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EDUCATION FOR CULTURE AND CITIZENSHIP

THERE has been of late much adverse criticism of the way in which the sciences are taught in schools and colleges of Great Britain. This criticism takes a variety of forms. It is asserted that the work is too specialized, that it is too academic, or that too much attention is devoted to the teaching of technique. The chorus of complaint may indicate that there is something wrong, but it does not follow that the fault is entirely with the teachers ; it is just as likely to lie with those who complain, and the danger is that their specious criticisms may influence the teaching in a wrong direction. If biological teaching, for example, is centred around man, as many educationists would have it, that teaching is bound to become subjective, and trouble is certain to arise (see p. 457). It is essential that the objective attitude should be cultivated and developed as fully as possible in all branches of science teaching.

Furthermore, some schools have taken up biology, for example, because it seemed to be becoming 'fashionable', and the school must be in the swim. An economic motive arises from the increase in the number of entrants into the medical profession, and from an erroneous idea that there is a large number of research posts in biology. It seems then that this subject has got into the curriculum partly upon sufferance and partly because a demand for it has arisen in the public mind. It is only here and there that it is taught as a worthy subject which provides appropriate training for a certain type of mind (a type more common than is often appreciated), and there is not as yet a sufficient realization that the training is as valuable as that afforded by a study of the so-called more exact sciences.

All sound teaching of the science subjects rests on several things, but above all on careful and accurate observation. Such careful and accurate observation is not within the capacity of an untrained observer ; the students have to be taught to observe. Critical observation breeds a critical habit of mind and a capacity for using the information obtained by the observation. It provokes and promotes thought. A person trained in the habit of observation applies that habit to all with which he has to deal. Training in observation and in the habit of mind it engenders is one great contribution which science has to make to education.

To train students in accurate observation is a severe test of the teacher's ability. Many students, rightly and naturally, take much pleasure in making preparations, in analysis, in dissection and in compiling books of drawings, but these things by themselves are not science. From the over-emphasis of technique and the memorizing of too many facts comes the widespread and erroneous opinion among those who know little and care less about science that skill in technique and the knowledge of a long list of forbidding terms make up the whole of science. It should be recognized that these are but means to the end, which is training in the art of close and accurate observation. There is a value also in the confidence the student gets from his ability to do something in a workman-like manner. Sound work in the sciences acts as a protection against over-hasty generalizations. The diversity which is one of the charms of plants and animals, for example, stimulates curiosity and keeps the mind alert. It makes the observer watchful, and it encourages a habit of mind which demands evidence rather than unsupported statements.

Practical work is important, but it must be kept in correct perspective. It must be within the capacities of the students ; for example, in biological work it will be mainly morphological, with a functional bias. Elaborately developed cytology and physiology do not provide suitable practical exercises, and consequently information has to be got from books rather than from personal experience.

There are special difficulties in teaching biology to town-bred children, though this is not true of all the sciences. While the town dweller is denied full access to much of scientific interest, yet he often has access to museums, zoos, gardens, works and factories which can serve him well, and could serve him better if close co-operation were established between controlling authorities. The cinema is becoming a more and more efficient instrument of instruction, and it can and should be used to supply something at least to compensate the disadvantages inevitably suffered by the student living in a large town. But the films must not take the place of direct work.

It is probably true that the greatest hindrance to science teaching is the examination system. Rightly or wrongly, teachers may consider it their main task to get their students through examinations, and if they do not themselves think so, that point of view may be imposed on them either by the administration or by public opinion working through the administration. The objective becomes the piling up of examination successes, and the bigger and more impressive the pile, the better the work of the school and of the teacher is supposed to be. All that being so, it is not remarkable that the schools may aim, not merely at getting as many examination successes as possible, but may seek to acquire additional merit by pushing as many pupils as possible through the stiffest and showiest examinations available. The subjects certainly suffer, and there is more than a suspicion that the welfare of the students may be sacrificed to the chance of academic successes for the school.

All this reacts on the mentality of the students, who get more and more the idea that the aim of their schooling is to enable them to pass examinations; the more stupid, and a very few with an abnormal dose of common sense may escape this. To pass the more showy examinations, specialization is thought to be needed, and this thought is gaining ground to such an extent that there is even talk of introducing research into the schools, a charming illustration of a tendency not unknown in educational schemes, that of starting a building with the roof and working downwards. Following this supposed need for specialization, we find harassed teachers attending scientific meetings, hastily grabbing up such crumbs as they can snatch, and decanting the fragmented results of recent research on their unfortunate students in the hope that this will scrape together a few more marks.

It seems clear that we must have some form of school-leaving examination to provide a test of how the machine is working, and to give an aim, for unless there is an objective the work is likely to be diffuse and pointless. But the present custom of having two such examinations, one at a lower and one at a higher level, is to be deplored. One examination should be sufficient, and it should be organized so as to provide an adequate test of the general education of candidates aged between fifteen and sixteen years. If the pupils stay in the school beyond the age of sixteen, they should not then be pushed on to specialized work ; that work should be done in technical institutions or in universities.

Older students who have given evidence of possessing satisfactory general competence should be allowed, during the later part of their school life, a temporary respite from examinations, and should be able for at least a year to pursue with some freedom whatever line of learning attracts them. That liberty, following several years of preparation for the School Certificate examination, would loosen up their mental joints and enable them, before they are caught up into industry or into a period of specialized training for a profession, to look around somewhat and perceive that scholarship is something more than text-books and formal lessons.

During this 'sabbatical year' the student might look aside somewhat from those subjects in which he may afterwards specialize. This would be the opportunity for the future student of science to give some time to arts subjects, and for the future arts student to profit from instruction in science ; both groups would benefit from some mathematics at this stage. At present, the student on the science side may be stultified by the repetition of the same kind of chemistry and physics year after year during his school life. He could profit well from instruction in the use of English during this period of recuperation (see p. 454). For some reason the writing of essays now seems to be taboo, and the study of English literature does not seem to be favoured. All this may explain the frequent and shocking illiteracy of students entering the universities. Let the student in this year of his freedom dip, as he feels moved, into the glories of English literature, but let there be no set books, no commentaries and no annotated editions.

If, for many, the older classics are too heavy going, why not use the moderns whose outlook is more in tune with our own ? Let the cinema be studied critically ; despite the welter of nonsense, there is much that is excellent. The gramophone and the radio will give an introduction to music and musical appreciation, and there should be ample time for history and geography, both studied with an eye to modern affairs and the problems of citizenship. Lastly, there should be the conversational study of at least one foreign language, French, German or Spanish, to get the student to lose his self-consciousness and to talk. Physical training is also desirable at this stage.

At the end of the 'sabbatical' year, those students who intend to train for the more technical side of commerce or for one of the professions should proceed for their specialized training to an appropriate college, where they would be freed from the school atmosphere and where they could begin to make wider contacts than are possible in a school. Their preliminary training for an examination of intermediate grade should not extend over more than one academic year. That period is amply sufficient for any college student of ordinary ability and industry, and there are no advantages, and very marked disadvantages, in spreading that phase of the work over two years, as is commonly done in schools. By taking the preparation for the first university examination out of the schools, time would be provided in the schools for some final inculcation of general culture, and, if one may judge from the results of certain public examinations, the transfer of the intermediate work to other institutions would materially improve the chances of the students in passing their preliminary professional examination at the first attempt —a very desirable thing.

The idea here expressed is to provide a break between the generalized and the specialized periods of the education of a pupil, not merely to give an opportunity for the acquisition of some general culture, but to mark that there is at this stage a change in the character and conditions of the work. The non-specialized training in particular could and should be made to support some simple instruction on the more obvious connexions between science and ordinary life. Thus the adolescent, before he is plunged into the task of completing his professional training and before he is immersed in establishing his position, is given the opportunity of getting a general view of things which a year of freedom from training for an examination would offer.

The aim of education is not to get students through examinations. When a child has spent several of his most impressionable years in being trained to that end, it is not surprising that he finishes with an altogether wrong idea of the importance of examinations. A transitional period between school and college, with no examination in immediate prospect, might well awaken broader ideas and broader ideals, and so help on the development of that most desirable type of citizen, the man who has self-respect because he can think independently and can express himself clearly to others. Any ordinary man would be outraged if it were suggested to him that someone should eat his dinner, digest it, and then pass it on; few ordinary men are as yet outraged because their mental food is commonly treated in this fashion. This is but one of the many ideas which might become more common with the wider diffusion of generalized teaching in science, and with that wider diffusion and the closer study of the impact of science upon society there may also come the realization that the present organization of human society is largely unscientific. Society cannot become a better thing for the average common man until it is in accord with the scientific principles which that man can appreciate and approve.

A SENTIMENTAL JOURNEY

Black Lamb and Grey Falcon

The Record of a Journey through Yugoslavia in 1937. By Rebecca West. Vol. 1. Pp. xi+653+16 plates. Vol. 2. Pp. vii+586+16 plates. (London: Macmillan and Co., Ltd., 1941.) 42*s*. net.

IN the eighteenth century, it was a diversion for those who could afford it to travel in a post-chaise through foreign parts, and thereafter to publish a gossiping guide, more or less observant and outspoken. Some of these works have become classics, and the practice is happily not extinct. But now one must go farther, one may travel faster, and by appointment one can see more various people; one also writes more gaudily than Laurence Sterne.

Here is a minutely annotated narrative of a spring tour in Yugoslavia in 1936. Rebecca West, already proficient in fiction, biography, and criticism, had lectured there the year before, and was fascinated by the land and the people. Though, as she says, she "knew quite a lot of Hapsburg history", she "knew nothing about the South Slavs"; so her industry has been great. But on her second visit she had a Government car with radio—a novel type of traffic-signal—a husband replete with common sense and restoratives, and as courier a Serbian official, Constantine, of Jewish descent, and resilient self-esteem, "one of the most gifted and learned men in Europe"; so the Serbian point of view was fully, though not exclusively, supplied. Of the Croat aspect of Yugoslavian affairs she is less well informed; her rare references to the Greeks are unsympathetic; she has no good word for Bulgarians, and she deliberately omits from her bibliography certain writers with whom she disagrees. But she liked the Albanians she met, and heard well of Albanians in general from her Serbian friends, and from Gospodin Mac, the wise manager of the Stan-Trg mine. As her own opinions incline to the Left, it was candid to describe as the most happy and prosperous community, where age-long feuds seemed to fade into mere neighbourliness, one created by foreign capitalists and governed by a Scottish dictator. Part of the trip was marred by Constantine's German wife, a repulsive character, cruelly drawn; and something went wrong, too, with Constantine; he was already ill at ease before he fades out of the book. Among all these aids and handicaps, two things are obvious: the ingenuous good nature of all classes of people, except a few political agents, and the personal achievement of Rebecca West and her husband, in eliciting so much intimate self-revelation and local commentary on what they were so fortunate as to see. Of the dialogues, some recall Thucydides' admission that his "speeches" were what might appropriately have been said.

Though the book, of some 1,200 pages, grows longer as one reads it, and has defects inherent in its circumstances and its technique, it has value for several reasons. First, it is a brilliant kaleidoscope of Balkan landscape, reviving treasured memories by its bold characterization of types, and insistence on the land's austere grip over man's fortunes, and on other men's devastation of laborious achievement. Some of this word-painting is difficult, like the pea- and plum-coloured landscapes that are skyed at the Academy; for colours, forms, and processes are oddly named—"savage" green, "sissy" flowers, "virile" water, "anfractuous" landscape, "enchanting camber" (the *profile* of an old bridge). Lake Scutari may be "earth's self-drawn ideogram, expressing its monstrosity" ooze-bound in greenish jelly (2, 426), but it is not a "fiord". Musical notation reinforces visual; internal disorder and sex-appeal lose vividness with iteration; mother-earth gives birth and is raped inordinately. The German girl condemned to an *Arbeit* on the works of West had scope for etymology as well as for æsthetic.

Then, of the people themselves, their racial types, and the thoroughbred humanity and physical grace of the best of them, there is direct and minute appreciation, and recurrent comparison—not new, but welcome confirmation from a fresh eye—with classical and Byzantine models, which are themselves only ideal because they embody just such personal experiences of contemporaries who could draw or write. Often we are on the hillside, not in Macedonia or Montenegro, but in old Ithaca, or with Achilles in his wrath.

Among these graphic glimpses of things seen and heard in such surroundings, the story, as Herodotus says, "loves parenthesis", groping back into medieval and earlier obscurity to answer Peterkin's question, "What they fought each other for"; and the answers lose nothing by being given before the tomb, or the church, or on the battlefield, which is landmark and datemark in one. Sensitive appreciation of Byzantine architecture and fresco-painting, and deeper sympathy than some historians have shown with Byzantine worship, enhance the perspective of secular events; many of which indeed ceased to be secular while the enemy was Islam, as they ceased again (so soon after!) when Cross met Swastika.

This leads to another and larger aspect of the book. In the spring, and especially at Easter, Orthodox belief finds expression in ritual, none the less potent, in the hands of a Bishop Nicolai, because much of it is not Christian at all. Here the "Black Lamb" of the title, a victim of St. George's Eve (2, 198*ff.*) provokes hysterical commentary, while Moslem incubation is condoned; and the "Grey Falcon" which brought King Lazar the choice between a temporal kingdom and an eternal (2, 292*ff.*) reveals him as "a member of the Peace Pledge Union" in distinguished modern company, and leads to a pendant onslaught on their political philosophy, preparing the way for an 'epilogue' to the whole book (2, 464*ff.*). These, like the fantasia on a foul latrine, and other incidents, are parenthetic writing at its weakest. But there is an adequate index.

There emerges—what has been hinted throughout the narrative—the writer's essential motive. After one of the Balkan conferences in 1913, one of the conspirators, congratulated on apparent settlement of claims, is said to have replied, "Well, there is always Serbia". It was the murder of King Alexander that roused Rebecca West to a sense of peril for herself and for all that she valued in this world. It was to analyse her own fears, and the motive for such crimes, that she devoted her gifts of eye and heart and pen; and she has brought her story on to the tragedy of April 1941, when the "Grey Falcon" came again. Much that she has written may be disputed now, some things may be refuted with fuller knowledge than hers. But she has seen much, studied widely, and thought hard, and it is not possible to read her indictment of the evils which have made South Slav fortunes so tragical, without realizing that what has happened in Yugoslavia does not differ in kind from perils that beset us all.

J. L. Myres.

AIDS TO AIR NAVIGATION

Astrographics, or First Steps in Navigation by the Stars

A Primer for the Airman Cadet. By Prof. Frank Debenham. Pp. v+118. (Cambridge: W. Heffer and Sons, Ltd., 1942.) 7*s.* 6*d.* net.

The Observer's Planisphere of Air Navigation Stars

By Ft.-Lieut. Francis Chichester. (London: George Allen and Unwin, Ltd., 1942.) 2*s.* 6*d.* net.

THE most reliable method of air navigation is by means of the celestial bodies. The time that can be devoted to training the air cadet in astro-navigation is necessarily limited. The air navigator can acquire all that he needs to know without much knowledge of mathematics, and can work more or less by rule of thumb; but the results are bound to be more satisfactory and the risks of error lessened, especially in an emergency, if he fully understands what he is doing. Prof. Debenham's little book has the commendable purpose of providing an easy approach to the principles involved by the use of graphic methods. A stereographic projection chart, with a matt celluloid rotatable disk, is provided to enable the spherical triangle to be solved approximately; stereographic scales are also provided, which make a somewhat greater accuracy attainable. These graphical methods undoubtedly give a greater insight into what is being done than is possible by the routine use of mathematical formulæ, and the cadet who studies Prof. Debenham's volume with understanding cannot fail to benefit from it.

A well-chosen series of exercises is added, to which solutions are given.

The book is unfortunately marred by a number of statements that lack precision or that are badly expressed, such, for example, as the following: a magnetic bearing is measured from a magnetic pole, which attracts compass needles, but does not stay in one place; the equator encircles the largest part of the earth; the parallels of latitude are equidistant from each other; on June 21 the sun's path is overhead all day along the Tropic of Cancer. It is stated that sidereal time is "a very useful kind of time, easily checked by observing any star's passage over the meridian, and with no tricky corrections to be applied"; this is not correct, for there are true sidereal and uniform sidereal times, just as there are apparent and mean solar times. The essential features of the Air Almanac are not explained; it is stated that "the airman wanted something handy in size, easy to understand and not burdened with too great a precision", yet the Air Almanacs for a whole year necessarily occupy a greater compass than the Abridged Nautical Almanac for seamen.

The use of haversine formulæ and tables could well have been omitted and a brief description given of tables providing a direct solution of the spherical triangle when an assumed position has been adopted; such tables are much more convenient and suitable for use in the air than logarithmic haversine tables.

Every air navigator should be able to identify with certainty the stars that are used in the Air Almanac, not only on dark clear nights but also on moonlight nights and with broken cloud. The special air navigation stars have been selected from among the brightest stars so as to give a reasonably good distribution over the sky. In the planisphere prepared by Flight-Lieutenant Chichester, these stars are shown, with sufficient additional bright stars to aid in their identification. The twenty-four principal stars, the altitudes and azimuths of which are tabulated for different hour-angles and declinations in the Air Navigation Tables, are indicated by name, the remaining navigation stars by their numbers in the Air Almanac, while the other stars shown are numbered and their names given in a key. The planisphere shows the air navigation stars visible at any time of the night or year to observers in latitudes 50° N. and 35° S. It should be a great help to air cadets in learning to identify the stars required for navigation.

H. Spencer Jones.

UTILIZATION OF STATISTICS IN RESEARCH

Statistical Methods for Research Workers
By Prof. R. A. Fisher. (Biological Monographs and Manuals.) Eighth edition, revised and enlarged. Pp. xv + 344. (Edinburgh and London: Oliver and Boyd, 1941.) 16s. net.

Since its first appearance in 1925 Prof. Fisher's book has become the standard manual of statistical practice for research workers throughout the English-speaking world, and new editions continue to be called for. This eighth edition follows the same lines as its predecessors, which have themselves grown from the first mainly by the insertion of supplementary material throughout the book, not by structural alteration.

One of the signs of the success which the book has enjoyed is a change in methods and emphasis over the last seventeen years which would have justified a rather more drastic revision. The author evidently feels this himself, for in the preface he excuses himself from "The difficult task of a fundamental rearrangement" on the grounds that "it is of real value to understand the problems discussed by earlier writers and to be able to translate them into the system of ideas in which they may be more simply or more comprehensively resolved". Perhaps so, but we may hope that on some future occasion Prof. Fisher will be able to find the time and opportunity to remould the book a little nearer to the heart's desire.

In some respects this is a difficult book, partly because of Fisher's condensed style and partly for a more important reason. The theory of estimation and the exact tests of significance with which it deals are based on ideas and derived by mathematics which are quite outside the ambit of the average research worker in the so-called natural sciences. It would have been impossible to give anything like a complete account of the theory in a monograph restricted to method; and thus the author was practically compelled to the course which he finally adopted, and to describe only the technique of his methods and to exemplify their use. In consequence the reader has to accept important results without proof and often without any hint as to how they were derived or precisely what hypotheses underlie them. If he is sufficiently interested and has the leisure to look elsewhere for the basis of the authority so much the better; but he will not find it in this book, and it is difficult to see how Fisher could have provided it without expanding a relatively short handbook into a comprehensive treatise.

This raises the question how far the powerful methods of modern statistics can be properly applied without some conception, however general, of their rationale. Its importance is heightened by the fact that the book, though not intended as a course of instruction for statisticians, is often referred to as if it were. Fisher has, in fact, suffered from a want of self-control on the part of some of his disciples, who betray a rapturous and undiscriminating enthusiasm which would be out of place even at a promenade concert. This in turn has excited a certain amount of criticism of the book. Orthodox statistical teachers have expressed doubts whether Fisher's broomstick can safely be entrusted to any apprentice who can memorize an invocatory formula. It is replied that one can use a telescope intelligently without being an optician. It is retorted that only qualified practitioners are allowed to administer powerful drugs. This sort of argument trails indecisively through a good deal of the statistical literature of the past fifteen years, but the whole question is one which might well be seriously discussed. In a large laboratory the difficulty may be overcome by the employment of a statistical specialist, and perhaps as research becomes more centralized the problem of the individual research worker who has to be his own statistician will disappear. But the question how far a knowledge of statistical *theory* is an essential part of the equipment of a research worker remains unanswered; it is a problem which could with advantage be studied by those responsible for the training of such workers.

However that may be, the influence of "Statistical Methods" on scientific method has been profound. To Fisher and his school goes the credit for having brought home to scientific workers two things. One is that the proper use of experimental data is itself a science which can be brought to a high degree of precision, even when the material is imperfect and the sample small. The second is that though in certain sciences and in certain classes of experiment error cannot be reduced, it can be controlled by experimental design. This latter lesson, indeed, has been inculcated by Fisher in a separate book and has not yet been fully learnt by research workers. It is a useful rule that statistical advice should be sought *before the experiment is carried out.* Most statisticians have met the case in which the results of an experiment could have been given a much greater significance, very often without additional trouble or expense, by adequate design at the outset of the inquiry.

Notwithstanding the interest aroused by the newer methods in statistics as applied to experiment, "Statistical Methods" has few competitors. To some extent this is due to the fact that it is largely a record of Fisher's own achievements, but that is not the whole story. The challenge of Fisher's ideas and his long record of success have made this book a sort of symbol of a new statistical creed and a banner around which his followers rally themselves. Research workers will long continue to buy this book, to wrestle with its ideas and to apply its methods to an ever-enlarging field of discovery.

M. G. Kendall.

PHYSICAL BASIS OF RADIOLOGY

Radiology Physics

An Introductory Course for Medical or Premedical Students and for all Radiologists. By Prof. John Kellock Robertson. (Textbooks on Physics.) Pp. xv+270. (London: Chapman and Hall, Ltd., 1941.) 18*s*. net.

THE applications of physics to medicine increase rapidly in number and scope, and there is great need of books which attempt to set forth the fundamental principles underlying these applications, either from the point of view of a fairly elementary student or from that of a more advanced worker in the subject. Prof. J. K. Robertson's book is addressed to the first of these possible audiences, and is a most welcome addition to the literature.

It is described as "an introductory course for medical or premedical students and for all radiologists" and represents a course of physics which is given to medical students at Queen's University (Kingston, Ontario) after their first-year preliminary training in physics. It is perhaps worth noting that the American Association of Physics Teachers is in favour of making the physics pre-requisite two years instead of one; this is a question which may well exercise those in Great Britain who are responsible for the scientific training of the medical undergraduate.

The book contains chapters on alternating currents, the production of high voltage, the "measurement and control of high tension voltage", cathode rays, positive rays and isotopes, Röntgen-ray tubes, valve rectification, general properties of X-rays, electromagnetic waves, measurement of wave-length of X-rays, secondary X-rays and absorption, Röntgen ray dosage, radioactivity, supervoltage tubes and high-speed particles, artificial radioactivity and high frequency currents.

The book is well written, though we may perhaps be allowed to protest against the title "Radiology Physics" or such phrases as "control of high-tension voltage" which sometimes occur, but such verbal infelicities are rare. Occasionally it seems that the order of certain sections might be altered with advantage, as for example the high-frequency current section, which might be brought forward into the earlier portion of the book dealing with electrotechnical matters, while the discussion of X-ray quality measurement and half-value layer would perhaps be more intelligible to the student if it followed the discussion of absorption and absorption coefficients.

In further editions of the book—and there should surely be others—the discussion on electromagnetic waves might also be expanded and more detail included. Possibly the difficulty arises from the fact that the book is intended for use by those who are presumed to have had the first-year instruction, but standing alone it seems advisable to discuss the elements of infra-red and ultra-violet physics more fully and more fundamentally than is actually attempted. The section concerning the relation of focal spot to wave-length is also isolated and might advantageously be expanded.

The diagrams are generally very clear, simple and accurate, but in spite of the legend the bending of the positively and negatively charged rays towards the poles of the magnet (Fig. 141) is rather misleading. These details are, however, very small blemishes on an excellent book which covers a large amount of ground simply, clearly and accurately, and the author has rendered a considerable service to physics in medicine by writing it. There can be no doubt that it will be very generally used in the training of both undergraduates and medical radiologists.

W. V. MAYNEORD.

RUBBER AT A TURNING POINT?

Rubber and its Use

By Harry L. Fisher. Pp. xvi+128. (London: Macmillan and Co., Ltd., 1941.) 7*s*. 6*d*. net.

DR. FISHER's small work is a model of excellent compression. Avoiding side issues and technical minutiæ, the book gives a clear, accurate and balanced picture of the development and present state of rubber science and technology. All the usual topics of a popular descriptive work of this kind on rubber are present. There are chapters on early history, sources of crude rubber, the plantation industry, crude rubber itself—its nature, properties, compounding and manipulation in the various manufacturing processes. Novelties arising out of the relatively less familiar processes of latex manufacture are not omitted. There is a revealing outline of the main types of vulcanized rubber articles, and a few pages on synthetic rubbers and on the chemical derivatives of crude rubber bring the discussion into the most recent trends of development of the industry. Dr. Fisher has had seventeen years experience with the large American rubber companies and, as he states, extensive experience in lecturing to student groups; from these experiences he has compounded the correct ingredients for a popular work remarkably well. Good illustrations add interest for the lay reader.

The present crisis in rubber supplies, created by the over-running of the Far Eastern plantations by Japan, has brought rubber forcibly to every mind and makes the present book timely even if the crisis itself is no part of the text. The crisis indeed may well make this book the last summary of one particular epoch in the story of rubber. There is no question that the only way out of the impending rubber scarcity is by way of synthetic rubbers. Reclaimed rubber and vulcanized oil substitutes are emergency palliatives of the first importance, but the rubber industry cannot live indefinitely on reclaim and factice. We are thus destined in the coming decade, and perhaps for much longer, to extensive use of synthetic rubbers of several types, aggregating possibly half a million tons a year when production reaches that figure in the next three or four years. Such a transformation of the rubber industry undoubtedly marks a turning point in its history of incalculable significance.

Both manufacturers and users of rubber articles will find fundamental differences between the coming epoch and that which is now closing. Whether we shall be able, or will wish, to return to present practices in the future is a complicated technical and economic problem of which no one can foresee the ultimate outcome. Dr. Fisher's book may well live as an apt summary of an epoch not destined to return.

Nutrition and the War

By Dr. Geoffrey Bourne. Second edition, revised and enlarged. Pp. xii+148. (Cambridge: At the University Press, 1942.) 4*s*. 6*d*. net.

IN these days of fortress economics, a special responsibility should burden those who set out to give information about food to the multitude, and it is only fair that their books should be submitted to searching criticism. From such a stern test Dr. Bourne's book emerges certainly not unscathed but with its fabric still fundamentally sound and a prognosis of useful service. It is entertainingly and well written and in places surprisingly up to date; its successive chapters deal in simple language with energy and food; proteins, fats and carbohydrates; vitamins; minerals, and nutrition in war-time. Nearly half the book is taken up by tables setting out the calorie, protein, carbohydrate, fat, mineral and vitamin content of a variety of products.

The advice given in the book is on the whole sound. At times, however, it is detached from reality, as in the author's unnecessary insistence on the paramount importance of citrus fruits, which are almost unobtainable, and his failure to indicate the excellent though more homely sources which everyone can produce in garden or allotment. A more serious point is the lack of appreciation that it is not so much the richness of a product in any given food factor as the amount consumed that matters in the end. This leads to the strange selection of curry powder as the best source of iron, and of 'Marmite' as nearly the best source of calcium. Alcohol gets an unexpected pat on the back and one almost fears that this misinterpretation of Mitchell's work might lead an enthusiastic planner of the family diet to prescribe it to children to make them grow faster and put on flesh. Fortunately, the commodity is in short supply. The weakest part of the book are the tables, which contain many mistakes. (Watercress and tomatoes are given as poor in vitamin A, but oranges and wholemeal flour are classed as fairly good; dried peas, beans and lentils are recommended as a source of vegetable fat, and so on.)

Frankly, Dr. Bourne will have to study his Fixsen and Roscoe and his McCance and Widdowson and do some drastic revising. The book is worth it and one looks forward to an improved third edition. Let us hope that by then a change in the title will also be needed. S. K. KON.

Tables of Physical and Chemical Constants

And some Mathematical Functions. By Dr. G. W. C. Kaye and Prof. T. H. Laby. Ninth edition. Pp. vii+181. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 18*s*. net.

IN the last thirty years this valuable set of tables has become so indispensable in the physics laboratory that every laboratory boy knows what to get when asked for "Kaye and Laby". If authors' names alone were to be used, accuracy would demand that far more than two be mentioned, for the original authors adopted the wise policy of securing the help of many others. As this edition, the ninth, was passing through the press, Dr. Kaye died and the Physics Department of the National Physical Laboratory gave a final inspection to the text and prepared the index. Prof. Laby, who took no part in the preparation of the eighth edition, has re-written for the present edition the tables dealing with units and dimensions, electrical units, conversion factors, mechanical equivalent of heat, velocity of light, general and atomic constants, α-rays, radioactivity, isotopes and arrangement of electrons in atoms. In one section the tables are ahead of time, because they include the electrical units originally proposed for adoption as "absolute" from January 1, 1940, by the International Electrotechnical Commission. The War upset the plan for general adoption.

The publishers have managed to find good paper for this edition. Twenty pages have been added to the book, and four shillings to the price. W. H. G.

Mathematics for Technical Students

By A. Geary, H. V. Lowry and Dr. H. A. Hayden. Part 3. Pp. viii+393. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 8*s*.

THIS is the third part of a series designed to provide the basic mathematical equipment for technical students, and to meet the requirements of the national certificate courses in engineering, building and chemistry. Each volume is planned to cover a year's work; the book under notice is thus intended to provide the necessary subject-matter for third-year students.

After a useful chapter on revision, the text begins with the progressions, binomial series, graphs of exponential functions, and the trigonometric addition theorems. The ground is accordingly well prepared for the calculus which follows. The modern method of developing the principles of differentiation and integration, side by side, is well carried out, and illustrated by applications to mechanical and electrical engineering. The final chapters are devoted to complex numbers, with applications to alternating currents, and alignment charts. There is a valuable summary of formulæ followed by a number of specimen examination papers. The student is well provided, at the ends of each chapter, with exercises for practice, to which answers are supplied. The book also includes an index and the usual set of tables.

Intermediate Algebra

By Neil McArthur and Alexander Keith. Pp. x+356. (London: Methuen and Co., Ltd., 1942.) 8*s*. 6*d*.

THIS excellent book reveals the rapid strides which algebra has made in recent times. A few years ago, "Higher Algebra" would most probably have been the appropriate title. The course is designed primarily for use in school and first-year university classes, the students of which have previously covered the work required for the first school certificate examination. The text deals, in a comprehensive way, with polynomials, partial fractions, equations, including determinants, indices, logarithms, simple series, graphs and the binomial theorem. The authors have provided a stimulating introduction on the basis of the course which should give the student an intelligent interest in the subject. Mention should also be made of the important chapters on graphs and the method of differences which lead, quite logically, to the calculus. Modern methods have been used throughout, and the treatment, in general, is not only sound but also very clear and well illustrated by worked examples. The aim of the authors has, indeed, been skilfully carried out and, as would be expected in such a book, ample exercises for practice have been supplied. Answers to these are given and a good index provided.

ENGLISH IN THE SCIENCE COURSE*

By HUGH LYON
Headmaster of Rugby School

THE Spens Report distinguishes three main purposes of English teaching: the first, "to enable a child to express clearly, in speech or writing, his own thoughts and to understand the clearly expressed thoughts of others"; the second, "the development of the power thus acquired to benefit the child as a social being, and to help him take his place as a thinking individual and a wise citizen"; and the third, "the training in the appreciation of literature". This division provides a useful basis for discussion, though it must of course be recognized that we are often, consciously or unconsciously, aiming at more than one of these objectives simultaneously. Indeed, the consideration with a class of any vital piece of literature should call into play both clear expression and comprehension, understanding of the subject-matter and literary appreciation.

I should like at the outset to deal with the vexatious matter of overcrowded time-tables. Science is a perpetually growing and expanding study; and though this may be, educationally, a stimulating and valuable thing, it is becoming a real difficulty to the administrators. Much of the work which was once done at universities is now delegated to the secondary school. The situation is becoming serious on the medical side, and real attempts are at last being made to meet it. But unless science teachers can discard old knowledge as rapidly as new truths are discovered there seems to be no real solution to the problem. It is easy enough in most other subjects; once we have grasped the geographical truth that the earth is round, we have not added to our curriculum, since there is no serious reason why we should continue to devote lessons to explaining that it is flat. And language study and even history can select for educational purposes from a field which, however far it extends, will never be too large for them. But science demands a knowledge of the whole, since (unless I am misinformed) it does not admit of short-cuts or arbitrary selection; it is moreover a practical study, which involves long periods in laboratories and considerable sacrifice of spare time. So it is not surprising that the young scientific worker is always in danger of over-specialization.

To my mind the minimum of non-scientific work a science specialist should do in a thirty- to thirty-four-period week is between ten and twelve periods: two of scripture, two of physical education, three or four of English, and three or four of a modern language. He should also have enough spare time to follow some non-scientific hobby, music or art or something of that nature. I have called this a minimum, but it is, I fear, a minimum very seldom attained and scarcely ever exceeded.

Up to the school certificate there is a blessed compulsion laid upon us all to keep the curriculum broad, and English normally gets its fair share of attention. But where other subjects are handicapped merely by the unfamiliarity of their context (whether this be Greek characters, French verbs, algebraical symbols or chemical formulæ) English has to struggle against the much more dangerous fact that most of those who are taught it think they know all about it already. Ideally, the first object of English teaching, training in simple expression and comprehension, should have been attained before the children reach the specialist stage. But this is not so, and often the young students who start on their special science course with a first certificate of general educational proficiency tucked into their pocket are in most cases incapable of expressing themselves clearly, either orally or on paper, and liable to make complete nonsense of a closely reasoned paragraph of simple prose.

One of the smart things to say about this business of teaching expression is that every master is an English master, and that teachers of other subjects ought never to pass slovenly or badly written answers. This is admirable doctrine; but there are two difficulties. The first is that it assumes that this part of English teaching can be done by a non-specialist (yet would the science teacher trust the English teacher to teach anyone even the rudest elements of science ?). The second is that when the science teacher asks questions he is concerned to get answers which are right in substance; credit is given—and rightly—for accuracy in matter of fact, and the quality of expression must be a secondary consideration. Moreover, whereas in language teaching English style comes to its own in all translation work, mathematics and science deal largely with symbols and not with words. The science master's main opportunity comes in requiring descriptions of experiments; this is admirably designed to test clear and accurate statement, since slipshod explanation defeats itself. Yet beyond correcting obvious errors and pointing out how defective expression distorts or obscures the truth, the science teacher as such can do little; he has not the time and it is not his job. Yet if he will just do this he is assisting the English teacher more than he realizes; for he has helped to break through the water-tight compartments between one school 'subject' and another, and taught his pupil (who always pays more attention to his specialist teacher than to any other) that good English is a means to something beyond itself.

The main fact remains, however, that the English master can neither assume that his pupils have been taught to express themselves and understand anything beyond the simplest books in their earlier years, nor delegate this part of his duty to the science department, though he will hope for its co-operation. He must do the work himself. How then will he do it ?

Partly, I think, by direct and formal instruction in syntax, grammar, punctuation and style; there are several ingenious books available which make these things palatable, and the teacher should be quick to seize any opportunity of using an odd five minutes in some such exercise. Indirectly, too, in the correction of essays or answer papers, he will have chances of directing attention to the pupil's besetting sins and suggesting remedies. These sins are of varying degrees of seriousness, and in some cases betray secrets of deeper disorder. Bad spelling may be carelessness or lack of observation or an eradicable and sometimes inherited disease; but there is nothing inherently vicious in it. Mistakes of grammar and syntax indicate a misspent youth and a slovenly habit of speech. A clumsy style suggests a lack of æsthetic sensibility and a lumbering mind. But none of these are so depraved as the commoner failing of bad punctuation, which is the sure reflection of inaccurate and slipshod thought. Commas and semi-

* Substance of the presidential address at the annual meeting of the Science Masters' Association held at Rugby School during April 8–11.

colons are as much part of the expression of an idea as the words in which it is embodied. They are not (as often seems the case) condiments to be sprinkled freely over the completed paragraph.

Oral expression should not be forgotten, though there is all too little time for it.

Hand-in-hand with expression goes comprehension. Boys learn to read very many years before they learn to understand, and considerable practice is needed before they can be relied on to extract the meaning from any but the simplest passages. Many of them cannot follow a set of instructions or the steps of a straightforward argument, so it is not surprising that they show such helplessness when confronted by a fairly stiff passage of Shakespeare or one of the more elementary official publications. Much here depends on practice, which is all the more valuable since you cannot test comprehension without giving training in expression as well. All good first school examinations include a précis, but this useful exercise tends to drop out of the curriculum later. Yet there is nothing like it for testing three most important things: first, the ability to realize what the writer means; secondly, the power to distinguish between the essentials and non-essentials in the matter presented; and finally, the art of expressing the gist of it in clear, simple prose.

The second and more important stage of English instruction is "the development of this power [of comprehension and expression] to benefit the child as a social being, and to help him take his place as a thinking individual and a wise citizen". The distinction between this and the previous stage is one of emphasis rather than of method or subject-matter. From the beginning there must be some care taken in the choice of the material for the English lesson; comprehension and expression cannot proceed *in vacuo*. But as the boy gets older we should be free to consider more and more not only how he expresses his thought but what his thought is like and how it is developing and expanding; and at the same time we should be demanding of him a deeper comprehension and a critical examination of the thoughts of others.

There will of course be scope for his thought and his critical power in his specialist work, but now that psychologists have more or less agreed that there is considerably less transfer of training than was once supposed, we cannot assume that an understanding of grammatical or biological variations will show itself in a clear grasp of political or moral distinctions. It is notorious that many men of outstanding ability in their own field have gone sadly astray when they have moved out of it. The same failure to transfer ability from one subject to another is found in all spheres of knowledge, and we must therefore not imagine that when we have taught a boy to make accurate deductions or detect fallacies in his own subject he will be able to do so in all. Still less, of course, can we introduce him to the material of other branches of study by means of his own special subject. It is here that English, which is for us the connecting medium between all our diverse little worlds, comes into its own.

We have already demanded ability to express and to understand simple ideas; we might go on to say that an educated man should have achieved some general philosophy of life and have accumulated some information about the world in which he lives. He should know roughly how it is arranged spatially and the broad outlines of the experiences it has gone through in the past two thousand years. He should be able to think politically, and have some convictions on questions of ethics and community life. Most of us would of course go much further than this, but here at any rate is a minimum for our consideration. How far in our English course are we helping boys to achieve the end desired?

The first necessity is to arouse their interest, which can be amazingly hard to do. The more absorbing a subject, the more it tends to fill the horizon; and the more frequent and searching the examinations, the less time there is for the cramped student to stretch his arms and grow to his full stature. "Born a man and died a grocer"; that is the epitaph of all those whose one aim in life is to go on knowing more and more about less and less. My experience as one of the board of interviewers for county major scholarships has revealed some rather dark corners of the educational field. Some of the candidates who have come before us, not infrequently those who are the most brilliant in their own subject, have never lifted up their heads to sniff the breeze and see the stars. They prate happily to us of the laborious progress they are making towards their next examination, confess at times to a mild fondness for the pictures or a penchant for draughts; at times they bicycle for exercise and are occasionally known to dig up weeds. But their world is sealed and they are comfortably at ease within it. The War has now, in its third year, battered a little rudely at their peace, but that after all is an interruption which in time will pass. But as for politics in the deeper sense, philosophy, mountain-climbing, music, literature, long walks in moonlight, bathes in sunlit streams, social problems, art, the blessed frenzy of argument, passion, adventure, God Himself—try them where you will and the bland, blank smile of polite boredom is your only answer.

This is of course a caricature, but like all caricatures it suggests a truth; and with all deference I must go on to say that almost all those candidates to whom it applied were specialists in science. It is not that science is in itself a narrowing study; but it demands so much time, and the standard required for success in examinations is so high, that literary, political, ethical, historical, philosophical and cultural interests all have to give way.

If we are to interest boys and girls in subjects to one side of their main line of advance, we must show them how necessary it is for them to explore the roads which lead to them. We must ask questions of them, questions which seem to them (as well as to us) to be important, questions to which they are anxious to know the answers. The mere unloading of information is of itself unappetizing, unless it either is immediately relevant to their particular subject, or comes in response to a demand. It follows that we should probe them a little, try to find by judicious inquiry where their imaginations are not dead but merely sleeping. If they have learnt at all to read (and courses of silent reading lower in the school should help towards this) we can discover which way their minds have been moving by letting them write an essay on any subject (other than science) under the sun. This for a start; it may give us a line of approach. Class debates and informal discussions will test them further; once their interest is on the move it should be kept spinning by any and every means, by provocation, by challenge, by illustration, by trenchant criticism, by genuine sympathy. But if the teacher, from his eminence, thinks fit to be superior or sarcastic or condescending—then small wonder if our young scientist returns gladly to his laboratory, thinking with savage glee as he completes his analysis how hopelessly lost his English master would be inside those sacred walls.

All this does scant justice to those few young scientific boys who have been among my own keenest and best-informed English pupils in the past few years. But it must be confessed they were the exception, and that both in quantity and quality the essays on political or general subjects shown up to me by my Science VIth have compared badly with those from the Classical or Modern sides. There are three stages through which young writers normally pass: that in which their essays are too short, because they have little to say; that in which they are too long because they cannot control their material; and that (reached only by the few) in which they have suited their length to their subject, having learnt to select and arrange both their thoughts and their words. Too often I find that, while I have to wade through vast compositions by young historians and modern linguists who have reached the stage of verbosity and cannot emerge from it, the comparative brevity of their scientific brethren is due more often to their having failed to pass out of stage one than to their having graduated into stage three.

Training in the appreciation of literature is a chancy business; it depends more than almost any other co-operative activity upon the nature of the two parties to the operation and upon the *rapport* between them. But if the pupil is to make our great heritage of literature his own he must both be sensitive himself and sit—at some stage in his career—at the feet of one of the chosen votaries of Apollo. All too often he enters upon his specialist course in none too congenial a mood. He may well have suffered under the meticulous dissection of a play of Shakespeare and the minor poems of Milton by a teacher whose horizon was bounded by contexts and classical allusions and the percentage required for a credit. In this teaching the teacher must be sincere, both in judgment and in enthusiasm. The teacher must also be sincere in criticism, such as frank recognition of Shakespeare's ludicrous failures as well as his triumphs. Such teachers win respect, and respect for them is half-way to interest in their enthusiasms. The second suggestion I would make is that here as in the earlier stage much can be done by asking questions which excite a desire to know the answer.

It is not for everyone to find in literature their chief delight. But we shall do our pupils wrong if we do not endeavour to reveal to them all what abiding happiness can be found in the company of great writers. This is after all the crowning achievement of the English teacher. To ensure moderately clear expression is much, and the first step to creating an intelligent electorate. To awaken interest in social, political and moral questions, this is more, and an enrichment of the life of man. But to open the doors of the imagination, this is best of all. For we are all of us, scientist and humanist alike, citizens of two worlds; and nothing that happens in this unhappy, tortured planet where man is at enmity with man can altogether overwhelm one who has heard the lute of Orpheus, or thrilled to the passion of Romeo, or looked with startled eyes through Keats's casements upon the foam of perilous seas.

THE SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING AT RUGBY

THE first full annual meeting the Science Masters' Association has been able to arrange since the outbreak of war was held at Rugby School during April 8–10, under the presidency of Mr. Hugh Lyon, headmaster of the School. The success of the meeting justified the venture; more than two hundred members were resident in school Houses, and many others made daily visits. The lectures were stimulating, discussions fruitful even when they developed unexpected trends, visits of particular interest, and the members' exhibition as good as any of its predecessors.

A liberal education draws its energy from many sources. It is a narrow kind of humane education which neglects the study of natural science; but it is a sterile form of scientific training which takes little regard of human relationships. The presidential address on "English in the Science Course" (see p. 454) and the biennial Science and Citizenship Lecture on "Biological Instruction and Training for Citizenship" given by Prof. Lancelot Hogben left the mind open to the wider views of life.

Biology and Citizenship

Prof. Hogben aimed high. He endeavoured to approach the great national and political problems caused by the impact of science on society. At the start of his lecture he cleared the air for what followed by examining the ideal of knowledge for its own sake.

Knowledge for its own sake presumably means knowledge for the sake of the individual, the pursuit of knowledge for the satisfaction of personal curiosity; and it goes without saying that individual curiosity is a necessary condition for the growth of knowledge. To that extent knowledge for its own sake is a formula which directs attention to a legitimate aspiration and to a sound educational principle. Most of us, including those alert to social agencies which provide scope for personal curiosity, would readily concede that personal interest in a particular line of inquiry or instruction depends on circumstances which do not necessarily or commonly have a close connexion with its social usefulness. Few of us imagine that precocious concern for the remediable evils of malnutrition determines the choice of a career in biochemistry. What we do assert is that a society more alert to the problems of malnutrition would furnish more ample opportunities for biochemical research and instruction. We find it difficult to understand why biochemistry should suffer from the efforts of those who wish to promote greater public esteem for the work which biochemists carry out; and we are not convinced that a person who professes supercilious indifference towards the welfare of his fellow-citizens is on that account a better biochemist.

If they mean anything at all, this seems to be what people suggest when they make knowledge for its own sake a battle cry in the discussion of science teaching in relation to citizenship. There is nothing particularly scientific about the egocentric attitude which refuses to recognize social relations as data relevant to personal conduct. That we are members of a social group is an inescapable fact. To what extent we get opportunities and encouragement to pursue our own interests depends on whether the pursuit of our interests harmonizes with the interests of others. In a democratic society this depends partly on whether we can convince our fellow-citizens that the pursuit of our own interests will benefit them. To conceal these simple considerations behind fine phrases such as 'knowledge for its own sake' merely shows lack of imagination and common sense. If personal curiosity is the only justification for the study of biology, there are no sufficient reasons for promoting its study as a school subject. Biology can justify its claim to a place in universal instruction if, and only if, it can establish its credentials as a branch of humane scholarship, that is to say, as an essential part of the intellectual equipment of the individual for the responsibilities of citizenship. This presupposes a common basis of agreement concerning civic obligations and privileges.

As a definition sufficient for the purpose of constructive discussion Prof. Hogben suggested the following. Those of us who subscribe to the democratic process believe in promoting social adjustment by rational assent of those concerned. Specialists need educating to a rational appreciation of the social value of professional work they perform. During the past twenty years the Fascist and Nazi regimes have systematically reorganized education to promote and consolidate totalitarian values and institutions. During the same period can any single country claim to have an educational system designed with equal singleness of purpose to encourage the survival of democracy ? The pioneers of British democracy did have definite views about the type of education which democratic government calls for ; but the curriculum of our educational institutions has not kept in step with the changing functions of democratic government. What views about education for government are widely prevalent in influential circles are a 'hang-over' from a period when the functions of democratic government were very different from what they are to-day.

To a large extent the change is due to the impact of scientific discovery on human society. If the functions of democratic government were still as when Milton claimed the right to know, to utter and to argue freely according to conscience, they would be equally important assets to-day. They are not. Our outlook is necessarily different from that of Milton's contemporaries. Meanwhile, we have patched up an educational system which served the needs of democracy well enough in the eighteenth century by making provision for the training of specialists for industry. There has been no radical change of the practice of education for government. What units of government are most suitable to changing conditions, and what new tasks Government can undertake in the interests of citizens increasingly become technical issues for which historical erudition supplies no precedent. Intelligent social decision depends on understanding what technical possibilities are realizable.

The fact that scientific knowledge can discipline human beings to cease striving for what they cannot have is not the only way in which it affects social values. Diffusion of scientific knowledge has a more positive role. To say that public health is now one of the major preoccupations of Government is to say that scientific discovery, and diffusion of knowledge by its implications, have enlarged the scope of human co-operation by enlisting us in a common struggle. Out of this new awareness of common dangers is coming to birth a new social phenomenon, the rational recognition of common needs which transcend our conflicting wants. We are learning to discuss whether people have the vitamins they need and to ensure that they get them. To the extent that we do so, the virus of scientific rationality is infecting politics.

The demand for biological teaching in the school is a new thing, and there is a widespread sentiment in favour of providing biological instruction of a sort suitable to the needs of pupils not destined to become professional biologists. There is much to be said for the provision of a more flexible curriculum in the universities and for the introduction of a general science degree for teachers ; but the administrative difficulties are great, while too many professors approach the issue with more concern for departmental prestige than for the civic value of what they can contribute. Biological instruction which can justify its claim to a place in a curriculum designed to promote intelligent citizenship must give prominence to aspects of biology which are most relevant to human needs. A comprehensive treatment of the field would emphasize the following themes :

(*a*) Animal parasitology, mycology and insect pests, that is, pests and parasites of man and of domestic animals or cultivated plants.

(*b*) Genetics in relation to plant and animal breeding.

(*c*) Bacteriology, serology and chemotherapeutics.

(*d*) Soil conditions and plant nutrition.

(*e*) Animal nutrition in relation to animal husbandry ; human nutrition, respiration and excretion *vis-à-vis* occupational diseases, and animal husbandry.

(*f*) Physiology of reproduction.

(*g*) Interpretation of vital statistics.

Prof. Hogben then dealt in detail with the broad background required, and the framework of specialized studies to be erected on it.

Biology as a Social Science

The lecture by Prof. Lancelot Hogben lent strong support to the main points raised by Mr. L. J. F. Brimble during the previous afternoon, when in a lecture entitled "Biology as a Social Science" he not only pleaded for a more definite realization in schools of the sociological implications of biology but also dealt with the practical ways in which teachers could put these to effect. At this lecture Mr. H. P. Ramage (Gresham's School) was in the chair.

There is a widespread feeling that the study of man should have a larger share in all general biology courses. This has, however, been wrongly interpreted by some. For example, certain biologists, especially in the universities, have expressed the fear that this might lead to man being used as a biological 'type'. Mr. Brimble dissociated himself from this view. In any event he gave reasons which he amplified later for considering man as an undesirable type in biological teaching because in certain fundamentals he is the exception rather than the rule. Another reason for emphasizing the sociological impact of biology is the strong movement which is now taking place in favour of the development of the social sciences, both in research and in education.

Mr. Brimble expressed his concern over the tendency of many teachers to make their science teaching too heuristic, in that they lean too much towards teaching science in the spirit of research and discovery. This may be all right in the universities but in the schools it leads to the students missing other aspects of their studies which are of equal importance. There is considerable danger involved in pressing for more practical work in schools. It is true that practical work well taught is of inestimable value, but it runs the risk of becoming biased in favour of the potential scientists. Practical work cannot, of course, be abandoned altogether since it is essential in order to drive home basic scientific facts and to satisfy the fundamental instincts of the pupil. To inculcate in the average schoolchild the spirit of discovery is, of course, very desirable, but by far the majority have no intention of taking up science as a profession in later life and many of them in any event have no leaning that way, yet those young students can derive as much benefit from a properly organized course of school science as any student who proposes entering the university as a science student. It is difficult to say what cultural benefit any boy or girl can derive in later life from an empirical knowledge of the analytical tables or of the structural formula for soap. On the other hand a knowledge of the everyday applications of chemical analysis can have certain cultural repercussions.

In biology as in any other science one must realize that though there is a minority who intend following careers which demand some detailed knowledge of biological science or medicine, and although these must receive consideration for the sake of the advancement of science, on the other hand much more consideration must be given to the fuller education of all students including the potential science specialists, in which historical background, the philosophy of science and the impact of science upon society have a full share of consideration.

One important factor, however, must be taken into consideration in all stages of the student's school life, and that is the time factor. Teaching hours are comparatively short—about thirty hours a week. If the ideal educational syllabus is to be achieved, however, one must decide what shall be taught and how much of what, and in coming to this decision the dead wood must be cut out and new shoots encouraged. This applies not only to the subjects themselves but also to the content of each individual subject, as emphasized also by Mr. Lyon. In other words, a more balanced curriculum is desirable and this must be periodically revised. In spite of the time factor, if it can be agreed that any subject, no matter what it is, shall be taught in schools, then time should be found for it, and in Mr. Brimble's opinion biology, which after all is the science of life, should be taught in all schools.

Mr. Brimble also discussed the dominating and destructive effect of the examination syllabuses as they are at present constituted. The attitude of many biologists and educationists towards biology teaching in schools leaves much to be desired. Their attitude can be ascribed to at least two things, namely, the lack of knowledge of the principles and importance of biology by those educationists, sociologists and even politicians who have had no training in the subject and also the attitude of a number of authoritative academic biologists themselves. This is evidenced to-day by the remark one is too often hearing that there is not much use for biologists as such in the war effort. How far this is true can be gauged from the successful formation and activity of the Biology War Committee (see NATURE of Feb. 28, pp. 227 and 234). If biology can be utilized in this way in war-time, how useful then could it prove itself, given the chance in peace-time. Biology is not just botany plus zoology; it is the science of life, and if it is going to win the place in the educational system of the country which it deserves then it must be treated as such.

Mr. Brimble then gave one or two examples in more detail of how present-day biological teaching could be so modified as to make the science more interesting and useful and to bring it to bear more directly on the study of man and mankind. He did not plead for a complete reorganization of the syllabus, since the most important factor is the frame of mind of the teacher himself. The biology syllabus even if it remains unchanged is seething with opportunities for dealing with sociological implications.

Experimental work can also utilize man as a subject. There is a tendency towards this to-day but it could be taken much further with advantage. At the same time it would be dangerous to centre the biology syllabus completely around man himself because in a considerable number of aspects he is the exception rather than the rule. For example, the conception of the survival of the fittest would be very difficult to teach if man were the main centre of interest. The question of reproduction raises several important issues which must be faced by the teacher. There seems to be little doubt that human reproduction should be given its logical place in the biology syllabus but teachers must realize that it is a delicate subject and one which must be dealt with very carefully, preferably after consultation with parents. Mr. Brimble expressed the view that it would be better that the subject be omitted than dealt with clumsily.

Principles of social biology confront us at every turn in the school curriculum; for example, individual and public health, nutritional standards, housing, population movements, race and nation, problems of family life, relations and responsibilities of one person to another, social policy of the State. Make social biology an academic discipline; then it will follow that in later life our schoolchildren will give effect to it as citizens in public administration and national policy. How deeply involved social biology becomes in national policy was illustrated by Mr. Brimble in his comparison of the attitude of Fascist powers towards social biology with that of the democracies.

Dealing with the teaching of biology in the Higher School Certificate, Mr. Brimble emphasized the deplorable domination at this stage of the requirements of the universities. The same point of view was expressed by a speaker in the discussion on "Science in Post-War Schools" (see p. 459). At present Higher School Certificate biology centres around the requirements of the first M.B. examination and the university intermediate and scholarship examinations. There can be little argument in favour of this. Indeed it is in the Higher School Certificate that biology might be treated more directly as social biology, though Mr. Brimble stressed the desirability of approaching it as such throughout the school, having once based the general precepts of biology in the lower forms of secondary schools and in the junior and senior schools more on observational science—especially natural history. In the Higher School Certificate stages sociology, civics and citizenship are often taught, and the biology course could be brought into line with these subjects or perhaps even be absorbed by them. In fact, after the School Certificate stage, a course of a year or probably two might well be based almost solely on cultural values. This, from the point of view of biology, was compared with remarks made by Mr. Hugh Lyon in his presidential address with reference to English.

In the discussion which followed, several valuable contributions were made, giving the general impression that the science master of to-day is anxious to emphasize more the social relations of the subjects he is teaching. Several speakers gave indications of what they were doing in their biological teaching along the lines discussed by Mr. Brimble. In the view of Mr. E. L. Walker (Caterham School), who gave several examples of his own teaching in social biology, there should be no difficulty in emphasizing the social impacts of biology. Mr. E. Lucas (Winchester College) also gave examples of his own methods and expressed the view that the social impact of biology should be brought out in the Higher School Certificate forms. Mr. Richard Palmer (lecturer in education, University of Liverpool, now seconded to the B.B.C.) made some very constructive remarks in favour of social biology and illustrated them with some excellent examples of what he and others are doing in school broadcasts. The method of teaching nutrition as practised by Mr. Palmer in school broadcasts followed closely those which Mr. Brimble would encourage; in fact Mr. Brimble used Mr. Palmer's method as an illustration of his own point of view.

Mr. Palmer and Mr. R. Weatherall (Eton College) did not agree with Mr. Brimble that man should not be treated as a central type. Mr. Bibby (Central Council for Health Education) made several valuable suggestions in favour of biology as a social science and expressed his disagreement with Mr. Lucas that social biology should be confined to the Higher School Certificate stage. Mr. Weatherall also expressed the view that Mr. Brimble's suggestions were too modest even at this stage, and considered that present-day biology teaching should be discarded in favour of social biology "from the cradle". Mr. Brimble replied that the course which he recommended teachers should adopt was probably not so modest as tactful. It is not possible in a democracy to get things done by revolution but rather by evolution, and he emphasized the fact that to put biology teaching on the basis which he and most of his audience desired depends chiefly on gradual modification of the teacher's attitude rather than wholesale discarding of the present principles and practice of teaching.

In his reply to Messrs. Palmer and Weatherall suggesting that man should be considered the central type, Mr. Brimble emphasized the pitfalls, giving the example of bacteriology. A knowledge of bacteria must come from a study of bacteria themselves and not from a study of man, otherwise there is the risk of giving the impression that bacteria only cause disease, whereas it should be remembered, of course, that there are as many useful and even essential types of bacteria as there are undesirable types. This can best be done by treating the bacterium as the type.

The general impression given by the discussion which followed Mr. Brimble's lecture was that teachers agree that biology should be treated more as a social science than it is, and that now is the time for educationists and teachers to approach the problem, since a golden opportunity is now at hand for making the subject of more comprehensive, cultural and therefore human interest.

Science in Post-War Schools

The discussion "Science in Post-War Schools" was opened by Mr. E. G. Savage, education officer to the London County Council, who was followed by Mr. S. V. Brown (Liverpool Institute). Mr. Savage foresees the danger that, at the end of the War, science in schools might be relegated to its previous position. He suggested that peace claims for science as the core of educational studies are even more exacting than those in war-time. Present curricula are conventional rather than rational, and both subjects and ways of teaching are dominated by examinations. He outlined seven aims of secondary education:

(1) Production of physical fitness and maintenance of health.

(2) Acquisition and practice of certain fundamental skills: speech, writing, calculation and capacity to think clearly;

(3) Production of qualities and development of aptitudes valuable in home life.

(4) Training for citizenship in a European democracy.

(5) Development of high ethical standards.

(6) Acquisition of knowledge and skills for proper use of leisure.

(7) Subjects as tools for probable vocations.

Mr. Savage examined the part which could be played by science teaching in all these aims.

Mr. Brown was more concerned with the work of the master. He pointed out that, of every hundred pupils who enter a secondary school, eighty-three take the School Certificate examination and sixty pass the examination. Fourteen enter for the Higher School Certificate of whom ten pass, and five, at the very most, go on to the university. He believes that what the teacher does, he does badly in the main, since he pays more attention to Higher School Certificate candidates than to the School Certificate forms; that the standard of a pass in School Certificate is too low, and that no pupil should sit for the School Certificate examination until he is at least 15½. The Higher School Certificate examination should be divorced from scholarship awards.

In the discussion which followed, many points of view were expressed. Nearly forty years ago Anatole France, an arch-apostle for Latin as the core of school-work, wrote: "Secondary education tends to strip itself more and more of that incomparable splendour which it derived from its apparent uselessness. Since such a transformation is necessary, since it corresponds to the change in customs, it is not very philosophical to lament it overmuch. Nations have an instinct for what suits them best, and the new France will doubtless find the teaching which her children need." France did not. Let us see that we do.

Atomic Structure in Chemistry

The chemistry discussion "Should an Outline of Atomic Structure be taught in the School Certificate Chemistry Course ?", initiated by Mr. A. W. Wellings (Leamington College) and Dr. E. J. F. James (Winchester College), provided lively debate and stimulating discussion. It was evident that chemistry teachers are aware of the need of making the atom problem more rational, and appreciate the part to be played by chemical studies in a coherent scheme of science teaching, in giving, not the conceit of knowledge, but an intellectual humility that recognizes that all their pupils learn and do is primarily to open up fresh horizons.

Teaching of Physics

The joint discussion with the Physical Society on "The Teaching of Physics", with Prof. Allan Ferguson in the chair, was divided into two parts : (*a*) "Fundamental Laws and Definitions"; Mr. C. W. Hansel (Bedford School) tackled the problems of the concepts of mass and weight and the systems of units involved, already familiar in his papers to the Physical Society; (*b*) opening the second half of the discussion, Mr. P. Woodland (Bedford School) stressed "The Need for a Permanent Standardisation and Guidance Committee for Elementary Physics". The main objects of such a committee would be (i) to introduce such a measure of standardization of definition, statement of laws, notation and conventions as would save teachers, students and examiners much wasted effort, and (ii) to issue each year reports on the work done in physics in schools and similar institutions, and to give advice on any changes in syllabus or technique which might be helpful both to those concerned in the teaching or organization of physics and to those who employ students who have learnt physics for a vocational purpose.

Many members followed the opening speakers in both sections and some differences of opinion were evident. The constitution of such a committee proposed by Mr. Woodland and the ways of enforcing its recommendations were then examined.

Visits were paid to the British Thomson-Houston Co. and to the English Electric Co. The Members' Exhibition was one of the successes of the meeting. Such trends as could be discerned were in the greater attention given to alternating current, the production of wireless and aerodynamical apparatus for A.T.C. instruction and in the use of small-scale apparatus in chemistry. A valuable exhibition of scientific books and publications was well attended.

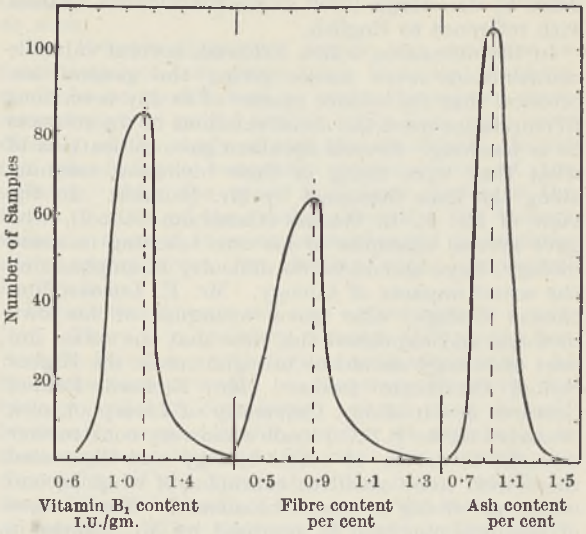
NATIONAL BREAD

By the Staff of the Research Association of British Flour-Millers

THE Medical Research Council in its second memorandum on bread[1] described in general terms the specification for 85 per cent National wheatmeal. It should contain 85 per cent of the weight of the clean wheat and in the case of a reconstituted meal should include all the white flour, all the reduction roll tails, mill finish and purifier tails and sufficient fine bran to reach the 85 per cent extraction figure. Analyses were given of meals prepared on the experimental plant in these laboratories, from which it was deduced that National meal should not contain less than 1 I.U. of vitamin B_1 per gm., and the fibre should not exceed 0·9 per cent.

The report further stated that improvers facilitate the work of the baker and lead to a more attractive loaf. Those normally used in the milling industry have been shown to have no effect on the vitamin B_1 content of flour or meal, and there is no evidence at present, on nutritional grounds, to justify their prohibition.

A few months ago the Ministry of Food arranged for a survey of the quality of the National wheatmeal being produced throughout Great Britain. Samples from more than 200 mills, large and small, were examined for vitamin B_1, fibre, ash, granularity and baking quality; in all, 303 samples have so far been examined, some of them being repeat samples from millers who had modified their methods.



Quality of Meals. The accompanying curves show the analytical results expressed as frequency curves. The modes and medians in the three curves correspond to the following figures :

	Mode	Median
Vitamin B_1	1·15 I.U./gm.	1·05 I.U./gm.
Fibre	0·85 per cent	0·70 per cent
Ash	0·95 ,,	0·95 ,,

Average figures for whole wheat are 1·3 I.U./gm., 2 per cent and 1·8 per cent respectively. The vitamin B_1 estimations were carried out by the thiochrome method[2] and could be duplicated with an accuracy of ± 5 per cent. The fibre was estimated by a method based on the Fertiliser and Feeding Stuffs Regulations 1932, with certain modifications. This method is routine in these laboratories and duplicate determinations on wheatmeals in general agree to within 0·05. The ash was determined on 5 gm. ignited in a muffle at 600° C., for six hours or overnight.

In view of the Medical Research Council's analytical criteria for wheatmeal, it is of interest to note that out of the 303 samples examined 253 had a B_1 content equal to or greater than 1 I.U. per gm. and 256 had a fibre content equal to or less than 0·9 per cent.

Quality of Breads. A meal conforming to analytical standards does not, however, always give a good loaf, and from the consumer's point of view the proper baking of National wheatmeal is just as important as its careful milling.

The absorption of each meal was determined by physical tests on doughs using special apparatus designed in these laboratories.

The moisture contents of the meals as received varied between 12·8 per cent and 16·1 per cent (5 hours at 100° C., in an electric oven):

18 per cent of the samples had moisture contents of 15 per cent or more
27 ,, ,, ,, ,, ,, ,, ,, ,, ,, 14½–15 per cent
28 ,, ,, ,, ,, ,, ,, ,, ,, ,, 14–14½ ,, ,,
27 ,, ,, ,, ,, ,, ,, ,, ,, ,, less than 14 ,,

The water absorptions varied between 14·9 and 17·8 gallons per sack.

This variation in absorption was only partly affected by the variations in moisture content, since when recalculated to a 14 per cent moisture basis it was found that :

8 per cent of the samples had absorptions of 17 gal./sack or more
32 ,, ,, ,, ,, ,, ,, ,, ,, 16½–17 gal./sack
41 ,, ,, ,, ,, ,, ,, ,, ,, 16–16½ ,, ,,
14 ,, ,, ,, ,, ,, ,, ,, 15½–16 ,, ,,
5 ,, ,, ,, ,, ,, ,, ,, ,, less than 15½ gal./sack

The variations in absorption are due to differences in wheat grist, severity of milling (as affecting starch damage) and composition of meal.

Each sample was baked at its correct absorption, using 1 per cent yeast and a total fermentation time of 5 hours to the oven.

The great majority of the doughs handled satisfactorily, but the general quality of the bread was not so good. The most striking point was the number of samples with under-developed crumbs, indicating the lack of sufficient improver treatment. Wherever the size of the sample allowed, a repeat bake was made after the addition of further improver, and in almost every case the resultant bread was satisfactory, the crumb being fine-grained and smooth and the loaf better risen. It should, however, be pointed out that the samples were baked probably only a few days after milling and that their baking quality would have improved with increased age.

A few of the meals contained too much bran. In others the bran particles were too coarse : in such cases the crumb tends to be weak and friable and the bread is difficult to slice. By contrast, we have found that if the bran is too fine (of flour fineness) the loaf tends to be muddy in appearance. The loaf with the most pleasant crumb appearance has a clean background colour on which the fine bran particles are superimposed. The water content of National bread (crumb) is generally about 47 per cent, that is, about 3 per cent higher than white bread.

Some of the breads examined had weak crumbs devoid of spring. These samples had high maltose figures due probably to the inclusion in the grist of damaged English wheat from last year's harvest.

Milling and Baking National Wheatmeal

Milling. The basal objectives of the Medical Research Council specification were the maximum germ and aleurone layer and the minimum of fibre.

Precise milling technique to remove the aleurone layer cannot yet be laid down and in fact, even in the case of the factors of germ and fibre, it is difficult to formulate a general procedure. Broadly speaking, however, the *excluded* products in the milling of National wheatmeal should primarily be the scalpings of the last break, that is, the bran both large and small (including pollards), which will constitute a variable but preponderating part of the 15 per cent aimed at. The balance of the excluded 15 per cent should be filled with purifier tins (1 or 2 per cent), the small amount of aspirated stock and selected purifier tails. These latter differ widely in character, some being comparatively rich in endosperm material. Those incorporated in the 15 per cent 'reject' should be the most fibrous, and if careful visual inspection is insufficient, samples should be assayed for fibre to help in the selection.

Alternatively, the 85 per cent meal should *include* :

(1) All the white flour (say, 75 per cent).

(2) All the mill finish and reduction roll tails (say, 6–7 per cent).

(3) All the germ normally separated (say, ¼–½ per cent).

(4) Certain selected purifier tails (say, 2–3 per cent).

(5) If required to make up the 85 per cent, the appropriate quantity of fine bran or pollards.

Some typical figures for the composition of these factions have already been published[3].

The assumption is made here that the purification system is still run on usual lines. This is a point for further investigation, but provisionally it is felt that the continued use of the system may be found helpful in excluding as much as possible of the undesirable fibrous coatings from the meal. This will be particularly so if the feed to the break system is drier or harder than in the milling of white flour.

Experiments which will be described separately have shown that for good keeping qualities the moisture content of the finished wheatmeal should be approximately 14 per cent. Allowing a 1 per cent loss in moisture during milling, the moisture content of the mill feed should not exceed 15 per cent. This, however, is only one aspect of the problem, and further work is in progress on the more general problem, the influence of moisture content on the composition of the resulting meal. There is, however, evidence to show that with a drier mill feed there is a greater separation of aleurone layer from the bran.

It is definitely undesirable to pulverize the bran (through 10-silk), the reason being, as stated above, that the presence of bran powder gives a muddy colour to the loaf. On the other hand, coarse bran pieces (coarser than 24 w.) give a friable, unsatisfactory crumb. Between these limits we have no precise experimental evidence but are of the opinion that the smaller the bran fragments the better the loaf. The work of Macrae[4] has shown that the size of bran particle does not affect its digestibility.

With regard to germ, our experiments show that it is immaterial whether the pieces are large or small.

If the mill finish and reduction roll tails go into the meal as well as the flour, the question arises, is it worth while carrying on these reductions or could the stocks normally feeding the particular rolls go straight into the meal ? To shut down these rolls would save power, wear and tear and operational demands ; it would avoid some disintegration of offal. At the same time it would lead to some endosperm being present in the meal in a coarser condition than would otherwise be the case. This point also requires further investigation, but our present evidence indicates that the granularity of the endosperm is not an important factor in National bread.

Unquestionably the use of improvers is more important than with white flour, because the response of the germy and low-grade stocks to such treatment is very great. Generally the dosage should be at least 50 per cent greater than with white flour ; the effect appears to be the same whether the white flour basis alone or the finished meal receives the treatment.

Breadmaking. In the past, brown bread has often been baked on very short systems using large quantities of yeast. This was feasible because of the relatively small quantities of such bread made, but now bakers will wish to make National wheatmeal bread on similar systems to those they have hitherto used for white bread.

Our experience with hand-made bread is that good quality National bread can be made on almost any system. As with white bread, the strength and soundness of the grist from which the meal is milled is a deciding factor in the quality of the bread, but in general a wheatmeal dough requires similar treatment to a white flour dough, that is, proper fermentation and correct handling. Any weakness in the grist or lack of correct fermentation or handling in the bakehouse will, however, be more apparent in wheatmeal than in white bread and, as has already been stressed, the need for correct improver treatment is particularly important.

To sum up, wheatmeal bread requires no real alteration to present-day baking methods, although for optimum quality bread greater attention to details, such as length of final proof, is desirable.

Conclusions

The survey showed that approximately 80 per cent of the mills were producing National meal conforming to the standards laid down in the Medical Research Council's specification. This survey was carried out when white flour, with its competing technical demands, was being milled.

There are a number of technical milling points which have to be investigated and explored before a meal, standard in all respects throughout Great Britain, can be produced. Equally, with greater experience of National wheatmeal, the bakers will be alive to the points requiring attention in order to produce National bread of the best quality.

It is of interest to note that the analytical criteria suggested by the Medical Research Council, namely, a vitamin B_1 content equal to or greater than 1 I.U. per gm. and a fibre content equal to or less than 0·9 per cent, apply on the commercial scale. In fact it may reasonably be expected that with appropriate modifications in the milling process, the fibre and B_1 figures will ultimately be improved still further.

[1] *Brit. Med. J.*, May 31, 1941, p. 828.

[2] Booth, R. G., *The Analyst* (in the press).

[3] Booth, R. G., Carter, R. H., Jones, C. R., and Moran, T., *Chem. and Ind.*, 60, No. 52, 903 (1941).

[4] Macrae, T. F., Bacon, J. S. D., Hutchinson, J. C. D., and McDougall, I., *Chem. and Ind.*, 60, No. 40, 723 (1941).

MATHEMATICAL MACHINES

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Rise of Modern Arithmetic

IN 1585, when Simon Stevin, the Dutch canal and military engineer, published his little book[1]* advocating the use of the decimal system, he opened up a new era in arithmetic. He dedicated his work "To Astronomers, Land-meaters, Gaudgers, Stereometers in generall, Money-Masters, and to all Marchants. . . .". If he had added to this list military and mining engineers and mentioned, as he does later, that the chief use of the astronomy was in navigation, he would have given a complete list of the social conditions which were calling out for the new arithmetic. For, as Hessen[2] has shown, the sixteenth and seventeenth centuries form a period in which capitalism, and especially merchant capital, was ousting the feudal economy in Europe and setting to natural philosophers a host of new technical problems—problems which formed the source of almost all the physical sciences of that period. It was to aid this new science, as well as to help the accounting of the merchants, that the new decimal system came into being.

Stevin's system was not actually new to the world, for its equivalent had been used by the Babylonians about 2000 B.C. But the social forces that brought about its rediscovery drove mathematicians to seek even better methods of computation. Thus in 1614 John Napier[3] published his logarithms. Without these, Kepler's computations and so Newton's "Principia" would have been impossible. It was to satisfy the same needs that the first attempts to construct calculating machines were made. Such were the machines of Pascal (1642), Morland (1666), Leibniz (1694), Leupold (1727), Stanhope (1775) and Hahn (1779)[4].

These machines between them contain practically all the devices that are used in modern "general purposes" (adding, subtracting, multiplying and dividing) machines. But though these men had the genius to conceive the basic principles, none of their machines was successful. The technique necessary to cut gears of sufficient accuracy and durability did not exist; the call for calculating machines was not sufficient to cause the technique to be developed for this purpose alone, and it was not until after the Industrial Revolution in Great Britain that a greatly increased demand for calculating machines, with a demand for mechanical efficiency in many other fields, gave sufficient incentive to force the solution of these technical problems.

The Industrial Revolution

The early part of the eighteenth century was a period of quiescence in the history of science. The scientific problems arising from the needs of mercantile capital had in the main been solved and it was not until the Industrial Revolution produced a demand for power, which could not be satisfied by the then existing means, that a revival took place—chiefly in problems arising from the steam engine, leading to thermodynamics, a subject which reached a reasonable degree of perfection about 1850.

Curiously enough, English mathematics did not keep pace with these scientific advances. Newtonian mathematics, representing essentially the needs of the older mercantile capitalism, was firmly established in the universities; the newer industrial manufacturing classes and the new sciences representing their needs had not yet succeeded in gaining a foothold there. In the early nineteenth century only one English university mathematician was facing the economic changes that were taking place and the revolution in mathematics that should accompany them. That man was Charles Babbage, Lucasian professor of mathematics at Cambridge. His book, "The Economy of Machines and Manufactures" (1832), must have seemed then a strange work for an academic mathematician, containing as it did a thorough analysis of the economic and technical aspects of the new industries. In "The Decline of Science in England" (1830), too, he shows a clear realization of the way in which the established scientific bodies (including the Royal Society) were degenerating, though he does not seem to have been really conscious that this degeneracy was a result of their lack of interest in the scientific problems which he so ably discusses in the other book.

It was this man, combining the tradition and educational advantages of an academic mathematician with a realization of the new fields that science

* References in this form are to the Bibliography at the end of the article.

must conquer, who made the next notable attempt to produce a practicable calculating machine. His two attempts were extremely ambitious[3,9,10]. First came his "Difference Engine", intended mainly for the construction of tables, the principle of which is briefly as follows: Consider, for example, a table of squares, beginning 1, 4, 9, 16, 25, . . . The first differences (that is, the differences between each number and its predecessor) read 3, 5, 7, 9, . . .; the second differences (differences of first differences) are 2, 2, 2, . . ., in fact, constant. Once this property has been observed, the original table may be extended by noting that the next first difference is $9 + 2 = 11$, and thus the next term in the table is $25 + 11 = 36$, etc. Thus we can calculate any number of terms in the table by addition only, instead of by multiplication, and similarly for other tables.

Construction of the machine was begun by the Government in 1823, but the work was suspended in 1834, when £17,000 had been spent, and abandoned in 1842. The chief reason for the failure and for the enormous cost was the want of proper machine tools for the execution of the work—the necessary technique was still not developed. The modern National accounting machine[11] is essentially similar to the one Babbage planned.

Babbage's second machine, the "Analytical Engine", was even more ambitious. It was intended to tabulate by punch-card methods the values of any function for which a finite mathematical expression can be written. Although Babbage began work on this machine in 1834, the technical problems were too great and little progress was made. The modern counterpart of this "Engine" is the Hollerith punch-card machine[12].

First Successful Calculating Machines

With the possible exception of the Thomas de Colmar "Arithmometer" (1820), no successful calculating machine was produced until the 1880's, when the continually growing demand, coupled with the accurate machine tools which were now available, caused an extremely rapid development of many efficient machines. The Brunsviga, for example, first appeared in 1892, and twenty thousand had been made by 1912. The Comptometer, the first successful key-operated machine, appeared in 1887; and many other successful machines were made about the same period[3]. Since that time no fundamental change has taken place in the ordinary calculating machine, though a multitude of detailed improvements have greatly increased its speed and efficiency[5,6].

Any machine which performs the four fundamental operations of arithmetic can, of course, be used to solve any computational problem. But in many cases the process is likely to be too slow and tedious. It is for this reason that we find, again in the nineteenth century, especially the third quarter, and in the twentieth century, the appearance of large numbers of more specialized machines, each intended to solve rapidly and easily some particular type of problem the importance and frequent occurrence of which makes it worthy of this special attention.

To begin with, there are the National and the Hollerith, which have already been mentioned. The former has its chief application in the preparation of tables and has been extensively used in computing the "Nautical Almanac". The second is used, among other things, for statistical analysis and has been applied to agricultural statistics[12].

The Differential Analyser

Differential equations have formed an important part of mathematics from Newton onwards, but in the nineteenth century and especially towards its end, they became so important as to force scientific men seriously to tackle the problem of their solution. At first various instruments, "integraphs"[13] were produced for solving special types of equations, but these sink to insignificance beside Kelvin's proposal for the mechanical integration of any ordinary differential equation.

The principle of the disk-and-wheel or disk-sphere-and-cylinder integrator for evaluating $\int f(x)dx$ had been used since the early part of the century in various integraphs and planimeters. Essentially it is a continuously variable gear. If the gear ratio is $1 : f(x)$ and the input shaft turns through an angle dx, the output turns through $f(x)dx$. If now the input turns continuously representing the variable, x, while the gear ratio is connected with x in such a way as to describe $f(x)$, then the total angle through which the output shaft turns is $\int f(x)dx$. By mechanical interconnexion of such integrators, any ordinary differential equation can (in theory) be integrated. In 1876 Kelvin pointed this out in regard to linear differential equations[7].

But the mechanical difficulties were too great. The friction drive from disk to wheel does not give sufficient power to drive the further mechanical connexions that are required. Thus Kelvin was unable to produce a working model, and indeed this was not done until about 1931, when Bush solved the problem of the 'torque amplifier'[13,14]. The principle of the torque amplifier is extremely simple; it is essentially the same as the capstan of a ship. The capstan is kept rotating, a rope is wound several times round it, and it is found that a small pull on one end of the rope produces a much stronger pull on the other end. With this addition, Kelvin's ideas can be put into practice.

Importance of Wave Motion

Physics of the latter half of the nineteenth century is very much concerned with wave motion. Maxwell's electromagnetic theory is its greatest theoretical achievement, but its real basis lies in two subjects of vital economic importance, which very much occupied men's minds at the time—telegraphy and tides. The first practical trial of telegraphy took place on the London and North-Western Railway in 1837. The first successful Atlantic cable was laid in 1865, and many technical problems arose in this connexion. Thus the discussion of the nature of the wave-motion in the cable assumed the utmost importance.

Investigations of tidal phenomena date, for obvious reasons, from the earliest days of the mercantile capital period, and notable work on the problem was done by Newton, Euler and Laplace. All this work was of a synthetic nature—attempts to produce general formulæ to represent the motion of the tides. But a gradual accumulation of evidence showed that the problem was too complicated to be tackled in this way. Thus, when the British Association appointed a committee to deal with the matter, Kelvin was led to suggest (about 1876) the alternative *analytic* method, namely, to analyse the tidal curve at any one spot into its simple harmonic components, to extrapolate each of these into the future and to recombine them to give the tide at any assigned future time.

These two sets of problems lent great importance to the harmonic analysis and synthesis of wave-motion, and it was not long before many machines were produced to deal with this problem. By Fourier's theorem the problem of finding the harmonic components of a periodic function $f(x)$ is equivalent to that of performing a set of integrations $\int_0^{2\pi} f(x)\cos nx dx$, for $n = 0, 1, 2, \ldots$. In 1876 Kelvin pointed out that such integrations could be performed by an adaptation of the wheel-and-disk integrator, as described above. Many machines have been constructed on this or similar principles, the most important modification being the use of several integrators simultaneously, representing several values of n. The next few years brought many harmonic analysers; for example, those of Henrici (1894), Sharp (1894) based on the principle just outlined and of Yule (1895), Michelson and Stratton (1898), Mader (1909) and Boucherot (1913) on other principles[3].

More interesting, perhaps, is Kelvin's tide-predictor (1876)[3,7]. In spite of its specific name, it is a machine for performing a synthesis of *any* system of harmonic components. It consists of a number of pulleys, conveniently arranged, each of which is given a harmonic motion. A wire, with one end fixed, passes over each in turn, and the other end then describes a motion which is the sum of the motions of the pulleys. Such machines are now in use in the navigation departments of several governments.

In recent times there has been a further outburst of harmonic analysers and synthesizers, such as those of Kranz (1927)[15], and Brown (1939)[16] based on the principle of the tide-predictor, and of Montgomery (1938)[17] using an optical method. The reason for this outburst seems to be the great crop of wave-motion problems arising from radio, the 'talkies' and quantum theory. Incidentally, by a simple mathematical trick, any harmonic synthesizer can be used as an analyser; it is very surprising that this does not seem to have been noticed before the 1920's.

Linear and Integral Equations

For reasons of space we can only refer briefly to two out of many other types of machines[8], though some of them are nearly as important as those described. The solution of sets of simultaneous linear equations is obviously an important problem, for example, in the theory of stresses in frameworks. Many machines have been constructed to solve such equations, for example, those of Kelvin (1878)[3,7], and Wilbur (1936)[19], working mechanically, and that of Mallock (1932)[18] on an electrical principle.

Just as differential equations describe, as it were, the point a system will reach, given only where it started and in what direction it is going, so also integral equations solve problems where the past history of a system is required to determine its present and future state. The importance of many such problems has recently grown enormously, for example, in hysteresis and in biological growth problems. Thus machines to evaluate definite integrals containing a variable parameter and so indirectly to solve integral equations are a recent development of considerable significance. They use optical methods[8,20,21].

Thinking in Terms of Machines

One of the reasons why mathematical machines were developed in the period after the Industrial Revolution rather than in the earlier merchant capital period was that the industrial period presented to the mathematician a much greater variety of problems which could only be solved within the given limits of space and time by the use of every available instrument. Another reason was that the Industrial Revolution had developed the necessary mechanical technique. To these must be added another reason, namely, the way in which men's minds had been altered by the circumstances in which they lived. Kelvin was in many ways the typical scientific worker of the latter nineteenth century, his activities ranging from what would now be called 'pure' research to detailed problems of applied technology and even to the application of his science as a very successful man of business, for he left a considerable fortune. Such men were used to thinking of the machine as typical of man's attack on the problem of living, and of a differential equation as representing the motion of a machine; and it was not difficult for them to reverse the process and make the machine represent and solve the equation. But to men of Newton's time a differential equation represented the motion of the moon or of a projectile, neither of which could be used conversely to solve the equation. Thus they were unlikely to think of machines as a method of dealing with their mathematical problems.

A similar ideological effect appears in the recent development of integral equations and machines for solving them. In the nineteenth century wave-motion must have seemed typical of the way of the world. It appeared in telegraphy and tides. But it also appeared as typical of history. The world seemed a more or less stable system; it had the wave-motion of the trade cycle, but it did not show obvious signs of a direction of development. But in the last two decades processes which were observed by only a few in the nineteenth century have become obvious to all. The world is changing; the old system is visibly breaking down and a new one is needed. Simple harmonic motion no longer adequately describes the world-machine, and the historical method of thinking becomes more and more necessary. It is in these circumstances that integral equations, the mathematical method of taking into account the history of a system, have so enormously developed. They arise from concrete problems, but it seems likely that the ideological background of a society in which history is so imminently visible has considerably helped their development.

Organization of Calculation

In spite of the headlong development of mathematical machines in the last seventy years, it remains unfortunately true that their vast potentialities are still largely unexplored. Many of these machines cost thousands of pounds to build. They cannot be constructed in order to solve a few problems. Yet there are many problems of such a nature that hundreds of workers all over the world meet half-a-dozen in a lifetime. At present that means to each of them many hours of laborious computing with a Brunsviga or even a slide-rule. An efficient organization with centralized laboratories to which all such problems could be sent would make it possible to provide machines to do this work in one-hundredth of the time and so would save the world many hours of valuable labour and enable the worker to spend his time more profitably than on handle-turning.

At least one attempt to provide a service in Great Britain on these lines has been established, on a business footing, and within its limitations has proved to be highly valuable. But such privately owned concerns may not be able to obtain all the more expensive and more specialized machines, which are at present mainly scattered throughout the laboratories of industrial companies, universities and similar institutions, where their use is practically restricted to members of the institution concerned. It would appear that the great possibilities of mathematical machines can be fully realized only through an organization supported by public funds, concentrating all types of machines under its care and using them to solve the problems of scientific workers wherever they may happen to be working. This must stand as not the least of the problems of social re-organization which confront the world to-day.

Future Trends

At present machine mathematics is widely regarded as being not quite respectable, not quite mathematics. This is especially the opinion of that school who see the chief justification of mathematics in what they interpret as its uselessness, combined with its "intrinsic beauty". Such mathematicians should take a warning from history. For theirs was the attitude adopted by English mathematicians of the eighteenth and three-quarters of the nineteenth century, with the result that, while Continental mathematics forged ahead, the English mathematician toyed with his "beautiful" problems of the Newtonian era, ignoring the fact that these had by then lost all relation to social usefulness and that the conditions of the Industrial Revolution were calling for new techniques. Thus it came about that Great Britain dropped far behind and had to be modernized with a jerk, when at last the scientific representative of the industrial capitalist burst into the universities, besides setting up his own research institutions.

There seems not to be a danger of this happening again. The real problems of to-day need machines, and machines have come to stay. If mathematics is to advance, it must recognize this fact and re-organize itself appropriately. This implies re-orientation in the light of the possibilities and the limitations of machines. To give one trivial example, in all machines so far in existence, the multiplication of two varying functions is an extremely awkward matter, while integration is comparatively simple. This suggests that our analysis should be 're-worded' so as to substitute integration for multiplication wherever possible. This, of course, may mean the loss of some formal elegance, but formal elegance must and will give way to the needs of practice.

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NEWS and VIEWS

Manuscripts of Charles Darwin

WE understand that the trustees of Charles Darwin are considering disposing of original MSS. of Darwin's which are in their care. These include the manuscript journal kept by Darwin during the voyage of the *Beagle* (1831–36) on which was based his "Journal of Researches into the Natural History and Geology of the various countries visited by H.M.S. *Beagle* . . .", Darwin's autobiography in his own handwriting with alterations made or suggested by Mrs. Darwin, the manuscript of "The Effects of Cross- and Self-Fertilization in the Vegetable Kingdom", the 1844 sketch of "The Origin of Species", and a large number of letters and miscellaneous material most of which has been published. Although this material may contain little of strictly scientific value, it has an obvious interest to the historian of science as revealing the workings of Darwin's mind at different periods of his life, and it would be unfortunate if the material should be dispersed. Such documents should be preserved in a library where access to them can be had by students, and it is to be hoped that some benefactor of science, aided perhaps by the Friends of the National Libraries, or some similar body, may be able to secure them for that purpose.

Future of Radio Communication

CAPTAIN P. P. ECKERSLEY addressed the British Institute of Radio Engineers at its meeting on April 18 on "The Future of Radio Communication". He dealt at some length with the limitation of communication channels available, for the whole of

Europe for example, without mutual interference, and explained that, although the number of possible frequencies available might be infinite, the useful range is not. He said that the service range of transmission might be said to be proportional to its wavelength, so that very high frequency transmissions have a very small reliable service area. If the band width occupied by a transmission could be reduced, the number of channels could be increased in the same proportion. Examples of narrow band transmissions cited included single sideband, suppressed carrier (for wired transmissions) and restricted modulation frequencies, and he mentioned an American invention by which an intelligible modulation range of 200–3,000 c./s. can be transformed at the transmitter to a range of from zero to a few hundred cycles a second, thus reducing the sideband frequency width to be accommodated, and providing further channels in a given range of carrier frequencies ; the signal is re-transformed at the receiver. Captain Eckersley still believes, in spite of theories to the contrary, that sidebands were real.

Dealing with wired broadcasting, Captain Eckersley expressed the view that this system would provide a solution to ether congestion, and envisaged a future when perhaps even a special cable would be laid to every house, not only in Great Britain, but also in every country of the world, linking continents as far apart as Europe and America, although he realizes the present difficulties of operating a submarine cable of such dimensions. The number of channels available in a wired system would be infinite, and in this, together with the American invention described, he sees in the future a solution of our broadcasting problems.

Development of Fuel Research

On March 26 Dr. E. W. Smith, director-general of gas supply, Board of Trade, addressed the Fuel Luncheon Club of London, choosing as his subject the question : "What do we want ?" By "We" he meant the British community as a whole and not the interests of some particular industry or individual. He suggested that fuel, heat and power supply is more important than any other future concern of the Government, even than agriculture. Unrestricted competition, he said, should be abolished. The utilization of coal has led to our growth of industry and population, but the advantages so gained cannot continue indefinitely, and possibly not for long. To raise coal and sell it abroad at a loss is folly. To do the same with competitive fuels at home is equally foolish.

The Board of Trade has brought into one control coal, gas, electricity and oil, but if a Ministry of Fuel were established it should do more than regulate these. It should be a highly competent body, independent of vested interests, capable of advising, with long views, on the whole fuel policy of the nation. Fuel is becoming dearer and the mere stimulation of coal consumption is wrong. Allocation of fuel for domestic and industrial use should be made according to what has been determined as the best for a given purpose. This calls for a development of research on a great scale, greater than any hitherto known in Great Britain. Fuel research should no longer be distributed among many competitive research organizations, but co-ordinated in one comprehensive scheme with directors of the specialized branches. It should then be done with the most ample and best-equipped facilities for experiment.

Statistical Theory of Accident Proneness

The scientific investigation of industrial accidents may be regarded as commencing in 1919 with the publication of a report by Prof. Major Greenwood and H. M. Woods for the Industrial Health Research Board, then known as the Industrial Fatigue Research Board, the data in which indicated that the hypothesis that persons were different in their liability to accidents from the start gave the best fit to the observed distributions. The mathematical considerations underlying these theoretical distributions were examined by Prof. Greenwood and Mr. Udny Yule in a paper published in the *Journal of the Royal Statistical Society* in 1920. A further paper on theory and observation in the investigation of accident causation by E. G. Chambers and G. Udny Yule has now appeared in the supplement to the same *Journal* (7, 89–109; 1941). In this, Mr. Yule gives a note on the statistical theory of accidents with special reference to the time factor, application of which to accident data leads to the conclusion that a lengthy period of experience is necessary for an individual proneness to accidents to manifest itself fully. Accident proneness may be regarded as a latent disposition needing certain circumstances to reveal it, rather than as an active function which is constantly in operation. Individual differences in accident proneness may, therefore, play their part chiefly in the earlier period of exposure to risk, their importance diminishing as the period of exposure increases. The maximum benefit gained by selective tests for proneness is, therefore, likely to accrue when the tests are applied to new entrants into risky occupations. The chief contributors towards accident rate might thus be found and eliminated during their most vulnerable periods. This conclusion is supported by the observed fact that selective tests are of much less value when applied to experienced workers than they are when given to new entrants.

To the discussion on this paper Dr. J. L. Irwin contributed an analysis of variance leading also to the conclusion that the most likely explanation of the differences between drivers is a difference in individual proneness to accidents, and Prof. Greenwood, commenting on the fact that Mr. Chambers had shown that a necessary condition for accepting the proneness hypothesis as a complete explanation of the fact is not fulfilled, agreed with his suggested explanation that the rate changes with time and pointed out that the study of Royal Air Force accidents might be of value here, since the high standard of selection probably eliminated the pathologically prone.

Fluorescent Light Sources

In a paper before the Illuminating Engineering Society on April 14, Mr. J. N. Aldington pointed out that two types of fluorescent lamp have been developed within the last decade, both of which employ the mercury vapour discharge as the source of primary radiation. In the first type, envisaged so long ago as 1900 by P. Cooper Hewitt, a high-pressure mercury arc operates with a high luminous efficiency, and fluorescent coatings on the outer bulb containing the arc tube produce colour modulation of the emitted light. Ultra-violet and violet radiation of a wavelength above about 3,000 A. is absorbed by suitable inorganic sulphides and is re-emitted in the visible region to supplement the dominant mercury light. The change in overall efficiency brought about by this energy transformation is negligible, but the effect on the colour-rendering properties of the emitted light is appreciable and useful. The second type of fluorescent light source is exemplified in the 80 watt MCF/U lamp, which was put on the market in March 1940, and is being used extensively for industrial lighting. A fluorescent powder layer coated on the inside surface of the tube containing a low-pressure mercury discharge tube is so vigorously excited by the resonance radiation from mercury that it produces about ten times the light given by an uncoated tube of similar size. The light is white and has colour-rendering properties sufficiently close to those of daylight for most industrial applications. The fluorescent layer is a mixture of inorganic powders which if used separately would give blue, yellow and red light and they are most efficiently activated by radiation of wave-length 2,537 A.

As the 80-watt lamp was designed primarily for industrial lighting to meet the demands of war-time conditions, the major applications in Great Britain have been in industry. Much experience has, however, been gained in the United States, where in the last three years fluorescent lamps have been introduced into practically every lighting field. It is found that the low surface brightness of approximately 0·5 candle per sq. cm. in the case of the 80-watt lamp and the large size of the source render it of great value for producing illumination conditions which can be made to approach daylight interior lighting. Shadows are softened and in a well-designed installation the illumination of vertical planes can be made effectively. In most cases stroboscopic effects are of little importance, the phosphorescence of certain of the powders used in the lamp construction assisting in bridging the gap between the cyclic changes in light output. The psychological effect of apparently cool light has proved advantageous in certain industries, and the freedom from glare in a well-designed installation is a noteworthy feature.

A Projected Canal System for England

IN a booklet entitled "The Projected Grand Contour Canal" (Birmingham: Cotterell and Co., 2*s*.), Mr. J. F. Pownall describes his ideas of a waterway linking together the main ports of England and accessible to coasting vessels up to 1,500 tons displacement, as well as canal barges. He points out that in the main watersheds of England, the lowest cols are at approximately 300 ft. As a result, he plans this canal to follow as near as possible the 310 ft. contour, which would obviate canal locks, with their delay and cost of upkeep, and necessitate only a few tunnels. Already some two hundred miles of existing canals lie at about 300 ft.; others are at lower levels. These might be linked by lifts, which have the advantage over locks in that they do not lose water in operation.

The main canal and its chief branches would be 864 miles long and would be 100 ft. wide at the water level, 17 ft. deep, with a clear headway under bridges of 80 ft. From London the Lea navigation would be used and improved as far as Hertford, where the new canal would begin with a lift. Thence it would pass through Bletchley, Rugby, Lichfield and Market Drayton to Manchester, with branches to Birmingham, the Trent and Wrexham. Through Lancashire it would pass by Clitheroe and Skipton, with a branch to Bradford and the Aire and Calder navigation, and thence along the eastern flank of the Pennines to Richmond and Newcastle, with a branch to Hartlepool. In the south, branches would reach Bristol and Southampton. At or near all the great ports, lifts would operate to and from the 310 ft. level. Sixty per cent of industrial England would thus be served at a cost which Mr. Pownall estimates at a halfpenny per ton mile. Other features of the suggested canal would be its service as a 'water grid' and as a line for gas, oil and other pipes which could be laid on its bed.

Wood Pigeon Nest Census

AN ecological survey of the wood pigeon's breeding habitats in Great Britain is being organized by the Edward Grey Institute, Museum Road, Oxford, as part of the British Trust for Ornithology's investigation into the biology of this species. The basis of the survey is a punch card, one being used for each occupied nest. The card is printed with a simple system of habitat classification; types of wood are illustrated by stating the name of the chief tree, shrub and flower. The finder also gives details of the position and contents of the nest, completing the hatching and fledging records if there are opportunities of returning to the nest. A punch card may be used at any time when a nest is found, but the maximum information is obtained from a census of any area of known acreage. If possible the census is repeated each month, cards being made out for nests not previously discovered and fresh information added to the old ones. The scheme is therefore flexible, allowing contributions from either an individual with only a few minutes to spare, or from members of a team; it also allows scope for organization within the team, encouraging those with specialized knowledge, such as a botanist, photographer, 'surveyor', and so on. For those proposing to organize a team census a pamphlet "How to Organise a Wood Pigeon Nest Census" is available from the Institute.

As the most active members of the Trust are now serving with the Forces a special appeal is being made to schools and youth organizations to help with the census. Several biology teachers are now using pigeons in dissection classes, and are studying crop contents, checking their identifications with observations in the field. A leaflet "Directions for Biologists" is available for anyone willing to undertake the examination of pigeons.

Lodgewood Telegraph Poles

C. H. AMADON, in an article on this subject (*Bell Lab. Rec.*, 20, No. 6, Feb., 1942), refers first to initial experiments made to preserve pine poles by creosoting, and secondly describes the method finally adopted. In the latter the poles are placed in closed cylinders and compressed air is admitted for about half an hour until the pressure rises to about 85 lb. per sq. in. Some of this air enters the cells of the wood. Hot creosote is then pumped in until the cylinder is full, pressure being maintained at 85 lb. per sq. in. during this period. More hot creosote is next pumped in until the pressure rises to about 135 lb. per sq. in. During this period of nearly three hours the creosote is taken up by the wood and fills its cells. At the end of this pumping period, air pressure is released and a vacuum is created under which the entrapped air brings to the surface most of the excess creosote, which drips off and is pumped out of the cylinder. The vacuum is broken after about an hour and live steam at a pressure of 20 lb. per sq. in. and a temperature of 260° F. is admitted to the cylinders and maintained for three hours to re-establish pressure in the wood and increase the fluidity of the remaining creosote. A vacuum is then drawn again and held for an hour, during which time more of the creosote comes to the surface and drips off. The vacuum is then broken and the cylinders are opened. Any liquid creosote on the surface of the poles is quickly reabsorbed, and the poles are reasonably clean. The first charge treated in this way completely satisfied all requirements. Approximately 50,000 full-length pressure-creosoted lodgepole pine poles have been treated according to the process described, with a high degree of conformity to the desired results in terms of penetration, consumption of creosote and cleanliness of the poles.

X-Ray Reflexion and Scattering with Frequency Change

THEORY and experimental work on the quantum reflexion and quantum scattering of X-rays are dealt with by Sir C. V. Raman in two papers (*Proc. Roy. Soc.*, A, 179, 289 ; 1942). The quantum or modified scattering is due to the excitation of the elastic solid or low-frequency vibrations of the crystal lattice by the X-ray photon. It has a very low specific intensity proportional to N (the number of lattice cells) and is distributed over a wide range of solid angles. The quantum or modified reflexion is due to the excitation of the infra-red or characteristic high-frequency vibrations of the crystal lattice by the X-ray photons. Its intensity, like that of the classical or unmodified reflexions, is of the order N^2, though usually smaller in absolute value than the intensity of the classical reflexions. The frequency changes which play a fundamental part in the theory of both phenomena appear as necessary consequences of both the classical and quantum theoretical points of view, but the law of intensity variation with temperature is quite different in the classical and quantum formulations. Experimental studies at low temperatures are specially important for the differences between the two theories. The influence of the modified X-ray reflexions on the intensity of the classical reflexions and their variation with temperature are discussed and shown to be of even greater importance then the effect on the same of the X-ray scattering by the elastic solid vibrations. In the second paper experimental results on diamond are reported agreeing with the theory.

An Improved Capacitance Bridge for Precision Measurements

To meet the demand for increased precision a new standardizing capacitance bridge, known as the No. 12 type, has recently been developed by the Bell Telephone Laboratories and is now described by W. D. Voelker (*Bell Lab. Rec.*, 20, No. 5 ; 1942). This bridge, operating at frequencies up to 200 kc., has a range of from 0 to 1·11 μF., and from 0 to 1000 μmhos. It is of the equal-ratio-arm type, the arms being of woven-wire resistance. A slide wire at the junction of the two resistances and an air condenser that allows capacitance to be shifted from one arm to the other, permit a small amount of adjustment that may be required at infrequent intervals to offset the effects of ageing. The resistances form the adjacent ratio arms of the bridge, and permit an unknown capacitance in a third arm to be measured against an adjustable standard capacitance in the fourth. This is the basic principle of the bridge. Conductance standards are included in the bridge. For measuring the larger values of capacitance silvered-mica condensers are employed as standards, while for smaller values of capacitance, air condensers are more convenient. The air-condenser standard consists of three decades of fixed capacitance and a movable plate condenser for fine adjustment. The control dial is calibrated to indicate directly the capacitance of the unknown for each position of the dial.

Medical Services in Sweden

THE March issue of the *Anglo-Swedish Review* gives an interesting account by Torsten Trietz of the organization of medical services in Sweden. Preventive medicine is administered by public health officers, of whom there is one in each of the twenty-four counties and larger cities. Outdoor medical treatment is provided by the following groups of physicians : (1) in the provinces the district doctor is a State official appointed for the medical care of the population in rural districts, who receives a fixed salary and retiring allowance ; (2) urban physicians, who are also salaried physicians but are paid by the municipality ; (3) private practitioners who are also paid a salary. Owing to their social importance tuberculosis and venereal diseases are compulsorily notifiable and free treatment is provided. There is a panel service national health insurance, of which the cost is borne partly by the State and partly by the fees of the insured. The public indoor service is mainly provided in general hospitals and is administered by the county councils or municipal councils, and paid for by the taxpayers. The hospital treatment of tuberculosis is organized in sanatoria, of which there are about 100 with about 8,000 beds. Care of infectious diseases in fever hospitals is compulsory for certain diseases and is free. Radiological treatment of malignant growths and similar diseases is organized in special cancer clinics at Stockholm, Gothenburg, Lund and Uppsala. All indoor relief of mental cases is administered by the State in some twenty hospitals containing 17,000 beds. The nurses in Sweden receive three years training in the larger hospitals in co-operation with the Swedish Red Cross. Midwives are trained at two colleges, and treat the vast majority of cases of childbirth.

Courses of the Lower Ganges

THE November issue of *Science and Culture*, which is conducted by the Indian Science News Association with the aim of advocating the application of scientific knowledge to the national welfare of India, contains an interesting article on the antiquity of the Lower Ganges and its courses. Mr. N. K. Bhattasali approaches the subject from the historical point of view. Little that is very definite emerges from Mahabharata and Pauranic literature, though a certain amount of evidence as regards the various mouths of the river suggests relatively few major changes. Ptolemy in A.D. 150 gave a full account of the Lower Ganges, and Mr. Bhattasali finds that, allowing the necessary corrections for Ptolemy's longitudes, the five mouths of the river are in approximately the same longitudes to-day as about nineteen hundred years ago. There are several maps in the article, including Rennell's map of 1761 and van den Broucke's of 1660.

Agricultural Scholarships

The Ministry of Agriculture and Fisheries is offering for award, under its scheme of scholarships for the sons and daughters of agricultural workmen and others, a limited number of agricultural scholarships. The scheme was suspended following the outbreak of war but has been resumed this year in a modified form, and the Ministry invites applications for the following scholarships: ten senior scholarships, tenable at agricultural colleges or university departments of agriculture, for diploma or degree courses in an agricultural subject or at veterinary colleges for courses in veterinary science; thirty junior scholarships, tenable at certain farm institutes or similar institutions, for courses not exceeding a year in duration, in agriculture, horticulture, dairying, or poultry husbandry. The scholarships are open to the sons and daughters of agricultural workmen or of working bailiffs, smallholders and other rural workers whose means and method of livelihood are comparable with those of agricultural workmen, and to persons who are themselves *bona fide* workers in agriculture. Further information concerning the scheme, and forms of application, may be obtained from the Secretary of the Ministry, Hotel Lindum, St. Annes, Lytham St. Annes, Lancs.

Recent Earthquakes registered at Kew

Between March 8 and April 7, four large earthquakes were registered at Kew Observatory. The first, on March 8, started recording at 04h. 56m. 35s. U.T., had a maximum of 32 μ at Kew at 05h. 14m. 26s. U.T. and finished recording at 06h. 30m. U.T. It may have started at an epicentral distance of 3,900 km. The second, on March 19, began recording on all three components at 12h. 19m. 42s. U.T., had a maximum of 17 μ at 12h. 42m. 12s. U.T. and finished recording at 13h. 50m. U.T. The third, on March 21, began recording at 23h. 33m. 38s. U.T., possibly from an epicentral distance of 10,200 km., had a maximum of 155 μ at 22d. 00h. 19m. 37s. U.T., and finished recording at 02h. 15m. U.T. This shock was also well recorded at Stonyhurst. The fourth was on March 22. It began recording at 02h. 17m. 18s. U.T. from a possible epicentral distance of 6,700 km. and finished at 03h. 50m. U.T.

Earthquake of April 8 in the Philippines

In Nature of April 18 reference was made to an earthquake of considerable severity (probably submarine) in the neighbourhood of the Philippines on April 8. This shock and two smaller aftershocks were recorded at Bombay. The Rev. J. P. Rowland, S.J., obtained a beautiful record of this earthquake on the Milne-Shaw seismograph at Stonyhurst College Observatory. The tentative readings of this seismogram tend to support an epicentre near the Philippines as suggested by Riverview. The shock began recording at Stonyhurst on April 8 with *i* at 15h. 58m. 00s. U.T., had a maximum at 16h. 34m. 30s. U.T. and finished recording at 18h. 31m. U.T.

The Association of Scientific Workers

The Association of Scientific Workers is holding its annual council meeting during May 2–3 at the London School of Hygiene and Tropical Medicine, Holborn, W.C.1. The Association has increased its membership from two to more than five thousand in the past year and has recently been affiliated to the Trades Union Congress. The main items for discussion will be the ways in which scientific workers and engineers can aid war production, and the need for improved professional status and educational facilities.

Following upon a memorandum from the Central London Branch of the Association of Scientific Workers, the Executive has set up a provisional Medical Sciences Committee "to further the objects of the A.Sc.W. among scientific and technical workers concerned with the medical and ancillary sciences". The provisional Committee has the immediate task of bringing together all members working in this field, as well as people anxious for the best application of knowledge in their place of work and for the war effort in general. The first meeting will be held on May 9 at 3 p.m. in the Small Conway Hall, Red Lion Square, W.C.1. Further information can be obtained from Dr. J. H. Humphrey, 32 West Hill Court, Millfield Lane, London, N.6.

Night Sky in May

Full moon is on April 30d. 21h. 59 m. U.T. and new moon on May 15d. 05h. 45m. Full moon occurs on May 30d. 05h. 29m. Lunar conjunctions with the planets occur as follows: Venus on May 11d. 07h., Venus 0·6° N.; Mercury on May 17d. 04h., Mercury 7° N.; Jupiter on May 17d. 20h., Jupiter 5° N.; Mars on May 19d. 13h., Mars 6° N. Mercury, Mars and Jupiter are evening stars, and Saturn is also an evening star until May 23, then a morning star. Venus is a morning star and rises about 3h. in the middle of the month. Mars, Jupiter and Saturn can be observed in the evening hours, but Saturn is too close to the sun to be observed well. Mercury is in conjunction with Saturn on May 5d. 10h., Mercury 3·8° N. The chief occultation occurs on May 16d. 11h. 35·8m. when α Tauri disappears, reappearance taking place at 12h. 55·9m. The Aquarid meteor shower is active during May 4–11. The radiant is close to η Aquarii about the middle of the period of activity of the shower, which is associated with the debris of Halley's Comet.

Announcements

We regret to announce the death of Prof. Jean B. Perrin, For. Mem. R.S., formerly of the Faculty of Sciences at the Sorbonne, Paris, at the age of seventy-one, on April 17.

Major Harry G. Armstrong, in charge of research at the United States School of Aviation Medicine at Randolph Field, Texas, has been given the John Jeffries award of the American Institute of the Aeronautical Sciences in recognition of his researches in the physiological and psychological effects of flying at high altitudes and in high-speed manœuvres.

The Nutrition Society is planning a whole-day conference on "Problems of Collective Feeding in War-time", to be held at the London School of Hygiene and Tropical Medicine, on Saturday, May 30, beginning at 11 a.m. Further information can be obtained from Dr. Leslie J. Harris, Dunn Nutritional Laboratory, Milton Road, Cambridge.

Captain L. F. Plugge, M.P., chairman of the Parliamentary and Scientific Committee, recently wrote to Dr. Hugh Dalton, president of the Board of Trade, about the clothing needs of scientific research workers and chemists. In his reply, Dr. Dalton said that research workers who require only a few overalls in the course of a year will not get extra coupons; an award to be made early next month will, however, provide for those whose needs are really very heavy.

LETTERS TO THE EDITORS

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

The X-Ray Microscope

IN NATURE of April 22, 1939, I described an optical method of summing a double Fourier series, and so of producing an image of a crystal structure. To get a projection of the structure in a direction parallel to the *b* axis, for example, holes are drilled

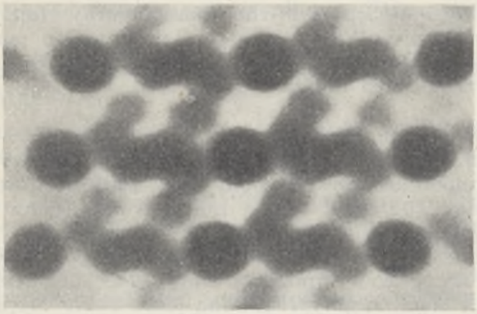


Fig. 1.
INTERFERENCE PATTERN (DIOPSIDE)

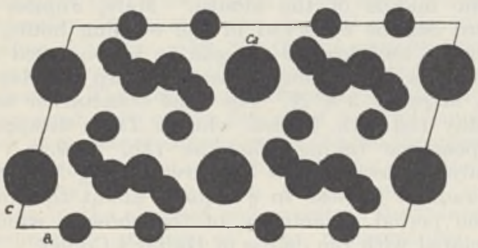


Fig. 2.
STRUCTURE OF DIOPSIDE, $CaMg(SiO_3)_2$, PROJECTED ON (010).

in a brass plate in the positions of cross-grating spectra. Each X-ray reflexion *hol* is represented by a hole the area of which is proportional to *F* (*hol*). When a parallel monochromatic beam passes through these holes, and then through a lens, the Fraunhofer fringes build up an image of the crystal structure which can be viewed through a microscope. Since a wide range of holes is required, and they are one or two millimetres apart, the smallest holes must be very fine. I am indebted to Dr. E. W. Fish for supplying me with a series of minute drills.

The present note describes certain simplifications in this method, and improvements in the perfection of the image. In the first place, we have found it possible to use a photographic reproduction of a diagram representing the cross-grating spectra in place of the plate drilled with holes. The paths of the waves issuing from the holes must be true to a fraction of a wave if the method is to work. To achieve this, advantage has been taken of one of the filmless photographic processes developed by the British Scientific Instrument Research Association. A drawing of the cross-grating spectra (represented by black dots of appropriate size) is photographed on a much reduced scale on a special type of plate. I am deeply indebted to Mr. A. J. Philpot, director of the Association, and Mr. Haigh, for making these reproductions for us. The black spots become transparent holes in the reproduction, and as there is no film over these holes and an optically true glass plate is used, the conditions for interference are satisfied. These photographs are much more perfect than the series of holes in a plate, and there is no restriction upon the complexity of the drawing.

Fig. 1 shows a photograph of an interference pattern representing diopside, $CaMg(SiO_3)_2$, the structure used to illustrate the method in the former note. This photograph was obtained with one of the plates prepared for us by the B.S.I.R.A. If it is compared with the former photograph, the considerable improvement in definition and extent of the pattern will be obvious. In Fig. 2 a diagram of the structure obtained by X-ray analysis is shown for comparison with the optical image, the atoms being represented by black dots.

In the case of diopside, *F* (*hol*) is positive for all values of *h* and *l* except (202). In the general centrosymmetrical case, both positive and negative values occur, so that a retardation to a path-difference of $\lambda/2$ must be introduced at the appropriate holes. We have found that this can be realized for two holes by cutting a half-wave plate of mica into small squares. To introduce a difference of $\lambda/2$, mica squares are placed one over each hole but with their fast axes at right angles. It is not necessary to polarize the light. This method might be extended to many holes, but the technical difficulties are rather considerable. It should be emphasized that the difficulties arise because path-differences must be right to a fraction of a wave; hence the squares must be cut from an extremely uniform mica sheet.

In making a Patterson synthesis, F^2 values are used and all coefficients are positive. Fig. 3 is an enlarged contact print of a B.S.I.R.A. plate representing the F^2 values of a horse methæmoglobin crystal measured by Perutz[1]. Fig. 4 shows the

Fig. 3.
PRINT OF B.S.I.R.A. PLATE, HÆMOGLOBIN SPECTRA.

Patterson synthesis obtained by optical interference using this plate. The pattern on the photograph corresponds in detail to the distribution of maxima on the contour map obtained by calculation (see Fig. 5). Although the phases are all positive and thus present no trouble, another technical difficulty is encountered in the case of Patterson syntheses by interference. The constant term is large compared with the coefficients F^2, and hence the central hole has to be much larger than the others. On the other hand, it must be so small that its first diffraction fringe falls well outside the central cell of the pattern, since the reproduction is only true inside the central diffraction maximum. In the present case this maximum is made to cover one complete repeat of the Patterson pattern by making the diameter of

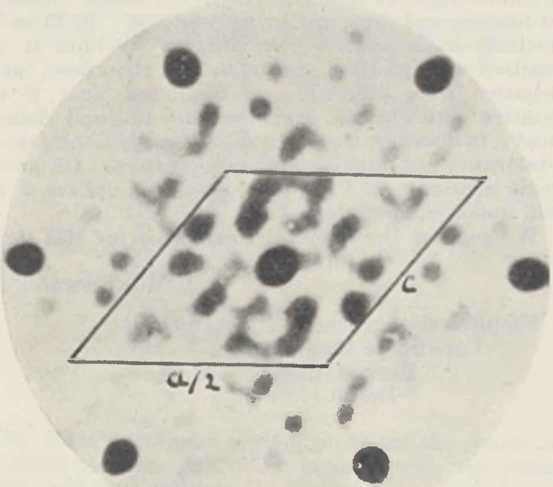


Fig. 4.
PATTERSON INTERFERENCE PATTERN (HÆMOGLOBIN).

Fig. 5.
PATTERSON SYNTHESIS BY PERUTZ, TO BE COMPARED WITH FIG. 4.

the central hole less than half the distance between neighbouring spectra. This requirement sets the scale for all the spots in Fig. 3. The method promises to be useful for the rapid summation of Patterson-Fourier series.

When taking photographs of the images, we have found it advantageous to use a filter to select monochromatic light from a mercury vapour lamp, and to place the panchromatic plate so as to receive directly the image formed by the microscope objective. The exposures are of a few minutes duration. If the photographs are made in a camera attached to the eyepiece of the microscope, exposures of several hours are required and the images are less perfect. I wish to express my thanks to the General Electric Company for the gift of the lamp used for this purpose, and to my assistant Mr. Crowe who has taken the photographs.

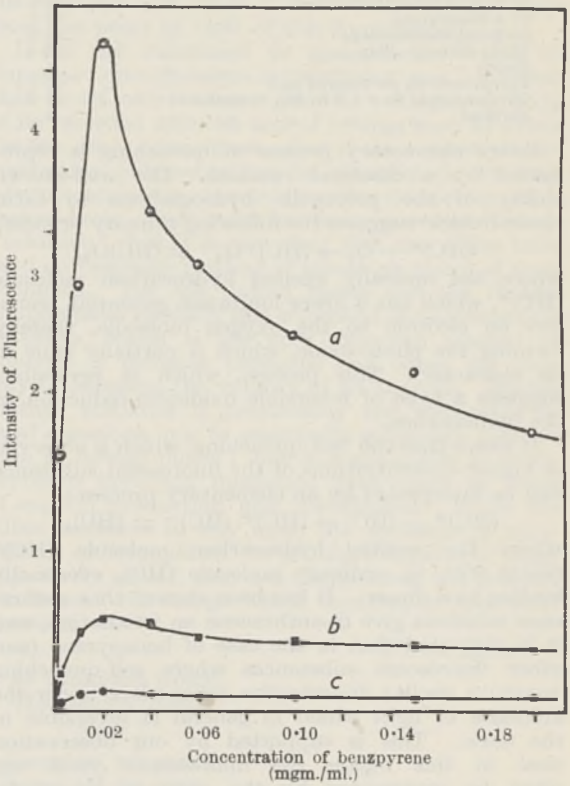
W. L. BRAGG.

Cavendish Laboratory,
Cambridge.
March 31.

[1] Perutz, M., NATURE, in the press.

Reversible Quenching by Oxygen of the Fluorescence of Polycyclic Hydrocarbons

DURING an investigation into the estimation of 3 : 4-benzpyrene by fluorescence measurements, great differences in fluorescence intensity were observed according to the solvent used; for example, the fluorescence is about five times as intense in tetraline as in hexane. These differences were found to be entirely due to a quenching effect of dissolved oxygen. In the absence of oxygen, the fluorescence intensity curves of a series of benzpyrene concentrations are practically identical in all the solvents studied. The most striking feature of the quenching by oxygen is its complete and instantaneous reversibility. The



FLUORESCENCE INTENSITY OF 3 : 4-BENZPYRENE IN HEXANE SOLUTION
(*a*), *in vacuo*; (*b*), in air; (*c*), in oxygen at 1 atm. pressure.

fluorescence of a given solution which has been almost completely quenched by oxygen is immediately and completely restored to its original value if the oxygen is pumped off, and this cycle can be repeated indefinitely.

In the accompanying graph the intensity of fluorescence (in arbitrary units) of 3 : 4-benzpyrene in hexane solution is plotted against its concentration for vacuum, air and oxygen of 1 atm. pressure. In the latter case the quenching amounts to about 97 per cent. At very low concentrations of benzpyrene the (unquenched) fluorescence increases almost linearly with concentration due to the correspondingly increasing light absorption in this region, whereas at higher concentrations the fluorescence yield decreases, obviously due to a 'self-quenching' effect.

A quenching effect by oxygen has previously been observed by Bowen and Norton[1] for solutions of anthracene in various solvents, and by Kautsky[2] and

Franck and collaborators[3] for chlorophyll solutions. In these cases, however, the effect is much smaller. The accompanying table shows the result of measurements with polycyclic hydrocarbons (some of them carcinogenic) and some other fluorescent substances under comparable conditions. Wherever a quenching effect of oxygen was observed, it was completely reversible.

PERCENTAGE QUENCHING OF FLUORESCENCE BY OXYGEN AT 1 ATM. PRESSURE IN ETHANOL SOLUTIONS CONTAINING 0·01 mgm./ml.

Anthracene	60·0
Chrysene	85·7
Pyrene	87·7
Rubrene	68·0
1 : 2-Benzanthracene	86·3
9 : 10-Dimethyl-1 : 2-benzanthracene	86·7
1 : 2 : 5 : 6-Dibenzanthracene	88·2
3 : 4-Benzpyrene	91·7
20-Methylcholanthrene	86·6
Ethyl chlorophyllide	32·1
Eosine	0
Thiochrome (in *iso*-butanol sol.)	27·5
Quinine sulph. (in 0·1 N. H_2SO_4 in methanol	17·5
Acridine „ „ „ „	0

Every elementary process of quenching is represented by a chemical reaction. The well-known ability of the polycyclic hydrocarbons to form photo-oxides[4] suggests the following primary process:

$$(HC)^* + O_2 \rightarrow (HC)^+ O_2^- \rightleftharpoons (HC)O_2,$$

where the optically excited hydrocarbon molecule (HC)*, which has a lower ionization potential, transfers an electron to the oxygen molecule, thereby forming the photo-oxide, which is partially ionic in its character[5]. This process, which is reversible, suggests a type of reversible oxidation-reduction of the hydrocarbon.

It seems that the 'self-quenching' which is observed at higher concentrations of the fluorescent substance can be interpreted by an elementary process:

$$(HC)^* + (HC) \rightarrow (HC)^+ (HC)^- \rightleftharpoons (HC)_2,$$

where the excited hydrocarbon molecule (HC)* reacts with an ordinary molecule (HC), eventually leading to a dimer. It has been shown[6] that anthracene solutions give di-anthracene on irradiation, and it is suggested that in the case of benzpyrene (and other fluorescent substances where self-quenching occurs) a similar dimerization takes place under the influence of light which in general is reversible in the dark. This is supported by our observation that in this region the fluorescence yield can often be represented by the common hyperbolic equation if the total concentration of the hydrocarbon in solution is substituted for the concentration of the quenching substance.

We are greatly indebted to Dr. F. Dickens for many valuable discussions, and to Prof. J. W. Cook, who supplied some of the hydrocarbons used.

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JOSEPH WEISS.

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April 2.

[1] Bowen, E. J., and Norton, A., *Trans. Faraday Soc.*, **35**, 44 (1939).
[2] Kautsky, H., *Ber. dtsch. chem. Ges.*, **64**, 2677 (1931).
[3] Franck, J., and Levi, H., *Z. physik. Chem.*, B, **27**, 409 (1934).
[4] Cook, J. W., Martin, R., and Roe, E. M. F., NATURE, **143**, 1020 (1939).
[5] Weiss, J., NATURE, **145**, 744 (1940).
[6] Luther, R., and Weigert, F., *Z. physik. Chem.*, **51**, 297 (1905); **53**, 385 (1905).

A New Salmonella Type

A NEW Salmonella type has been isolated by us from the mesenteric gland of a normal pig. It ferments, with the production of acid and gas, glucose, mannitol, arabinose, dulcitol, rhamnose, trehalose, sorbitol, lævulose, mannose, galactose and xylose; and does not ferment lactose, sucrose, adonitol, erythritol, inulin, raffinose and salicin. It is indole-negative and H_2S-positive, reduces nitrates to nitrites and does not hydrolyse urea; in Stern's medium it is positive; in Bitter's medium it is positive with glucose, arabinose and rhamnose, and negative with dulcitol; on Simmons' agar it is positive with glucose, arabinose, dulcitol and rhamnose; it does not liquefy gelatine and is *d*-tartrate-, *l*-tartrate-, mucate- and citrate-positive. Its antigenic structure is VI_1.VIII; ⟷*e,n*. . .(phase 2 is still under examination).

We suggest the name *S. bonariensis* for this new type.

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Catedra de Bacteriología,
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March 17.

Structure of the Branchiæ of *Carcinus maenas*

NOTHING is known concerning the histology of the branchiæ of *Carcinus mœnas*, except for a brief account using Bouin-fixed material[1]. By fixation in Champy, whole-mount preparations of strips of a lamella stained in iron alum hæmatoxylin show that a system of branching tube-like structures is present.

The exact morphology of these structures is difficult to determine, but it is believed that they are tubes or sculpturings in the cuticle. Seen from above (*P*, Fig. 1) they form a series of connected

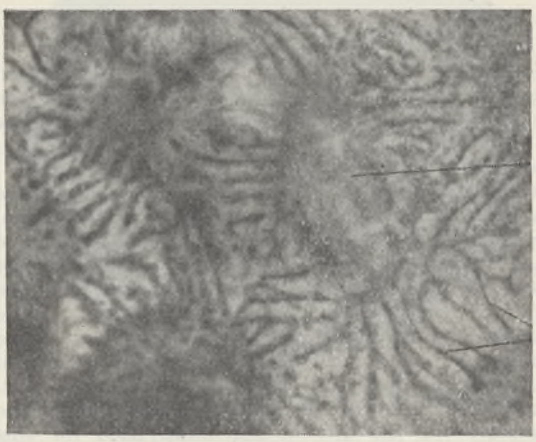

Fig. 1.

systems extending radially out from certain areas, corresponding in position with the large pillar cells (*E*), which lie directly beneath.

In transverse section of the lamella, shown diagrammatically in Fig. 2, the structures are seen as a series of dark striations (P') in the cuticle (C). Directly below these a number of tubes (T) extend deeply into the pillar cells, apparently forming a continuous arrangement with those of the cuticle.

There is no evidence available as to the possible function of these structures; but it is suggested that

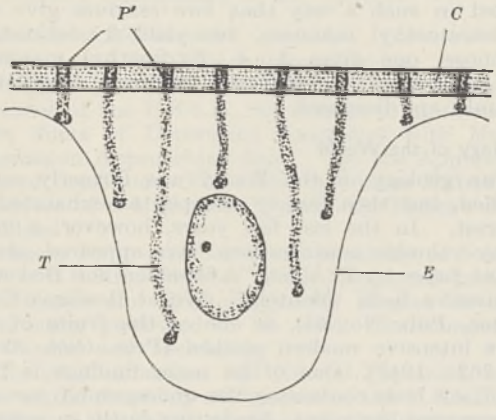

Fig. 2.

they form a tubular system whereby the water is enabled to come into close contact with the pillar cells, and thus assist in the oxygenation of the blood circulating between these cells.

J. D. Smyth.

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Trinity College,
Dublin.
Feb. 3.

[1] Webb, D. A., *Proc. Roy. Soc.*, B, **129**, 107 (1940).

Committee Decisions and Mathematical Statistics

Dr. Blakeslee is surprised that there is not a higher degree of unanimity of the Supreme Court of the United States[1], but a believer in the subjectivity of opinion would expect very much what Dr. Blakeslee records in the tantalizingly few data he gives. In some matters there can scarcely be two opinions. But the ordinary matters of government are commonly settled by committee decisions—of which those of the Supreme Court are a type—or else by the decision of some one man. If the values of the opinions of men *inter pares* are equal, one would premise first, that a wrong decision is equally as likely to emerge as a right one from subjective processes; and secondly, in relation to complex and obscure questions such as those with which superior courts necessarily deal, that the voting would correspond to some distribution of mathematical probability. Some critiques of examination results ("examinations of examiners") support these views[2]. It would be interesting to know how often a decision of a lower court of law is reversed or upheld by a higher.

Referring solely to a committee of nine members, all of whom vote, I may point out that if decisions were absolutely random the distribution of judgments in which the members were unanimous, or divided 8–1, 7–2, 6–3 and 5–4, would follow the binomial distribution ($n = 9$) 1, 9, 36, 84, 126. Thus a unanimous decision could be expected only once in 256 cases, and an 8–1 or a unanimous decision once in 25. The 6–3 and 5–4 decisions would constitute more than three-quarters ($\frac{210}{256}$) of all the decisions, and a decision of a higher degree of unanimity than 6–3 would occur only once in five or six cases.

Though the data supplied by Dr. Blakeslee are too few to have more than coincidental value, it is interesting to note that the two 6–3 and three 5–4 decisions he mentions are precisely in the ratio indicated by the binomial hypothesis. May I hope that someone with access to recorded decisions of the Supreme and other courts would examine them from the point of view of this hypothesis?

I am not concerned to question the value of Supreme Court decisions in particular, and I mention that Court only because there is evidently a body of its recorded opinions and of votings such as exists for few other committees. But if the subjectivity of committee judgments can be established, we may advance some way towards putting democracy on a factual basis. Much scorn has been poured on Hitler's "intuition", but it is not clear that the Allies have used any sounder method of attacking many of their problems. Yet the United States and the British Empire have virtually sole command of mathematical statistics, which is the only objective method of analysis of complex problems and offers the only way of assessing the validity of an analysis. Mathematical statistics is presumably not applicable to legal questions, nor to essentially subjective matters such as foreign policy; but it is applicable to many problems involving numerical data—such as those of supply, production and distribution. While the Allies continue to rely upon the decisions of committees or 'strong men' for problems capable of being objectively solved, they are disregarding the greatest intellectual advantage which they enjoy over their enemies.

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April 7.

[1] Nature, **149**, 288 (1942).
[2] Nature, **136**, 966 (1935).

Physiology of the Amino Acids

The valuable and comprehensive review by Dr. van Slyke[1] fails to discuss one problem, the most important of all from the point of view of human nutrition. Accepting W. C. Rose's classification of amino acids into essential and non-essential, he has omitted to make clear, though it is implicit in his review, that this information applies only to experimental animals, indeed, only to the experimental rat. It would be interesting to know what evidence, direct or indirect, exists, if any exists, as to the indispensability or dispensability of any individual amino acid for *Homo sapiens*.

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Greenford,
Middlesex.

[1] Nature, **149**, 342 (1942).

RESEARCH ITEMS

Biological Estimation of Vitamin P Activity

A. L. Bacharach and M. E. Coates discussed this subject at a meeting of the Society of Public Analysts and Other Analytical Chemists held on April 1. Modifications of Zecho's method for measuring capillary resistance in guinea pigs having revealed its suitability as a basis for biological estimation of vitamin P, a provisional laboratory standard has been assigned the value of 1,000 units per gram: this material (W.S.P.1) is a water-soluble concentrate, similar to Szent-Györgyi's 'citrin', made from citrus peel. Recrystallized hesperidin has been found to have an activity of 95 units (probable limits of error, for $P = 0{\cdot}95$, 73–138 per cent), while a water-soluble concentrate made from blackcurrants has the high value of 10,600 units per gm. (probable limits of error, 79–126 per cent). Tests of this degree of accuracy are conducted on thirty to forty young guinea pigs, using two doses of standard and two doses of unknown. Rough exploratory tests, using six animals, have confirmed the presence of vitamin P in other citrus concentrates, in a reaction mixture obtained by partial esterification of highly purified hesperidin, in rose-hips and rose-hip syrup, in blackcurrant juice (pasteurized) and in blackcurrant *purée*.

A Modified Hilger Vitameter A

At the meeting of the Society of Public Analysts and Other Analytical Chemists held on April 1, R. J. Taylor described a modified instrument for estimating vitamin A. Greater accuracy of calibration is attained by using, instead of a standard glass test piece, a dilute solution of a dyestuff, benzene-azo-*p*-cresol. This has an absorption curve resembling that of vitamin A with a maximum at 325 mμ; its E (1 per cent, 1 cm.) value can be determined accurately by means of a spectrophotometer, and its use automatically eliminates any small error in cell thickness. The modifications made in the instrument itself are: (*a*) a more versatile electrode holder, which reduces fluctuations of the copper arc, (*b*) a light-tight photographic paper holder, and (*c*) a pendulum type photographic shutter, giving a succession of short exposures instead of a single longer exposure at any one setting. After approximate visual setting, records are taken on a piece of gas-light paper at a series of neighbouring settings, from which the correct setting is ascertained. The instrument need not be operated in a darkened enclosure. The overall error has been reduced from about ± 10 per cent to about ± 3 per cent.

Constitution of Yeast Mannan

Yeast mannan, which is a polysaccharide extracted by alkali from baker's yeast, was shown by W. N. Haworth, Hirst and Isherwood in 1937 to be essentially homogeneous and composed exclusively of mannose residues, and its acetate and methylated derivative were studied. A further examination of the substance has been made by W. N. Haworth, R. L. Heath and S. Peat (*J. Chem. Soc.*, 833; 1941). It is shown that tetramethyl mannose, trimethyl mannose and dimethyl mannose are produced on methylation and that the tetra-fraction consists of tetramethylmannose and the di-fraction of 3 : 4-dimethyl mannose. The tri-fraction, however, is not constituted entirely of 2 : 3 : 4-trimethyl mannose; this sugar, in fact, does not make up more than 10 per cent of the tri-fraction. The main constituents are 3 : 4 : 6-trimethyl mannose and 2 : 4 : 6-trimethyl mannose, which are present in equimolecular proportion and together constitute 90 per cent of the fraction. This result throws light on the probable structure of yeast mannan, which is considered in the paper. The repeating unit of yeast mannan would appear to be composed of six mannose residues linked in such a way that two residues give rise to tetramethyl mannose, two yield 3 : 4-dimethyl mannose, one gives 3 : 4 : 6-trimethyl mannose, and one forms 2 : 4 : 6-trimethyl mannose. Alternative formulæ are discussed.

Geology of the Weald

The geology of the Weald was formerly much studied, but then largely dropped as exhausted of interest. In the last few years, however, a good many valuable contributions have appeared, and a recent paper by P. Allen, "A Wealden Soil Bed with *Equisetites lyelli* (Mantell)" (Weald Research Committee, Pub. No. 31), is one of the fruits of the more intensive modern studies (*Proc. Geol. Assoc.* 52, 362; 1941). One of its main findings is that fossil soil beds containing the underground parts of a large reed-like plant, *Equisetites lyelli*, in position of growth are widespread, thus proving the existence of terrestrial even if swampy conditions; and there are indications that these conditions occurred repeatedly. The underground organs of *E. lyelli* had been previously described, but their nature was not fully realized, and the species was ill characterized although it had been reported from the lowest Cretaceous rocks of various European and American localities. The present description of the rather thick elongated rhizome and the unbranched aerial stems makes this one of the best-known species of its genus.

A High-Voltage H.R.C. Cartridge Fuse

In a paper read on April 15 in London before the Institution of Electrical Engineers, K. Dannenberg and W. J. John describe the construction of the two-element, powder-filled cartridge fuse and its effect on protection technique. The provision made for adapting the fuse for oil-immersion, and the striker-pin mechanism which ensures tripping on all three phases should only one fuse be blown, are described in detail. Discrimination in operation between fuses and other protective gear is discussed. Experiments are mentioned which show the ability of powder to prevent corona formation on the fusible conductor. A reduction in the magnitude of the transient voltages produced on fuse operation can be obtained by changing the section of the fusible conductor in one or more places. A series of tests on the behaviour of high-voltage fuses on short-circuit in an ordinary 50-c./s. system is presented and typical oscillograms are given. A test is also described which reproduces the operating conditions obtained when a rectifier backfires, and oscillograms are given showing the behaviour of the fuse under such a test. Fuses like those described have been developed for a rupturing capacity up to 1,000 Mva. at 66 kv. It is suggested that h.r.c. fuses can be used to improve fuse-switches, to act as a back-up to safeguard old circuit-breakers in cases where the short-circuit burden has been increased, and in combination with a simple load-breaking switch in which the switch deals with small overloads only, all short-circuits and heavy overloads being cleared by the fuse.

STALIN PRIZES FOR SCIENTIFIC STUDIES

IT is announced by the Tass Agency that the following awards of Stalin Prizes for outstanding scientific work in 1941 have been made by the Council of People's Commissars of the U.S.S.R.

Physics and Mathematics

First prizes (200,000 roubles each) to:

Serguey Bernstein, member of the Academy of Sciences of the U.S.S.R., for studies in mathematics "On Sums of Dependent Quantities with Mutual Regression Approaching Zero", "On the Approximation of Continuous Functions by Linear Differential Operator of a Multimolal", and "On Fisher's Probabilities".

Abram Joffe, member of the Academy of Sciences of the U.S.S.R., director of the Leningrad Institute of Physics and Technology, for studies in semiconductors published in his work "Semiconductors in Physics and Technology".

Leonid Mandelstam and Nikolai Papaleksi, members of the Academy of Sciences of the U.S.S.R., for studies on the theory of the oscillation and spread of radio waves.

Second prizes (100,000 roubles each) to:

Alexander Alexandrov, of the State University of Leningrad, for studies on the "Existence of a Convex Polyhedron and Convex Surface with Given Metrics" and "The Internal Geometry of Convex Surfaces".

Vladimir Kuznetsov and Maria Bolshanina, of the Kuibyshev State University in Tomsk for a study of "The Physics of the Solid Body".

Technical Sciences

First prizes (200,000 roubles each) to:

Boris Kalerkin, member of the Academy of Sciences of the U.S.S.R., for his studies in the theory of elastic equilibrium of cylindrical casings, together with the work on "Tensions and Changes in Circular Cylindrical Piping".

Sergei Khristianovich, corresponding member of the Academy of Sciences of the U.S.S.R., of the Central Zhukovsky Aero-hydrodynamic Institute, for a study on "The Flow of Gas around a Body at High Sub-sonic Speeds", "The Efficacy of Compressibility on Characteristics on Wing Contour", "Super-sound Flows of Gas".

Second prizes (100,000 roubles each) to:

Metislav Keldysh and Eugenii Grossman, of the Central Zhukovsky Aero-hydrodynamic Institute, for studies in the prevention of breakdown of planes, "Calculation of Flutter in Aeroplanes", "Oscillation of a Wing with Elastically Attached Engine" and others.

Chemical Science

First prize (200,000 roubles) to:

Nikolai Zelinsky, member of the Academy of Sciences of the U.S.S.R., for outstanding contributions to organic chemistry.

Second prizes (100,000 roubles each) to:

Ilya Grebenshchikov, member of the Academy of Sciences of the U.S.S.R., director of the State Optical Institute, for studies in optics of great significance for defence.

Peter Rebinder, corresponding member of the Academy of Sciences of the U.S.S.R., for his studies "The Importance of Physical and Chemical Processes in the Mechanical Destruction and Treatment of Solid Substances in Technology" and "The Acceleration of Deformation of Metallic Single Crystals under the Influence of Absorption of Superficially Active Substances".

Geological and Geographical Sciences

First prizes (200,000 roubles each) to:

Alexander Fersman, member of the Academy of Sciences of the U.S.S.R., director of the Institute of Geology, for his study "Useful Minerals of the Kola Peninsula".

Akhad Yakubov, vice-chairman of the Azerbaidjan Branch of the Academy of Sciences of the U.S.S.R., for the study "Mud Volcanoes of the Western Part of the Apsheron Peninsula and their Connexion with Oil Bearing".

Second prizes (100,000 roubles each) to:

Kanysh Satpayev, vice-chairman of the Presidium of Sciences of the U.S.S.R., for the study "Ore Deposits in Dzhezkazghan District of the Kazakh Republic".

Vasilii Shuleikin, corresponding member of the Academy of Sciences of the U.S.S.R., director of the Black Sea Hydrotechnical Station, for a study "Physics of the Sea".

Biological Sciences

First prize (200,000 roubles) to:

Yakov Parnos, of the Institute of Biochemistry of the Academy of Sciences of the U.S.S.R., for research in metabolism in muscles published in the work "Glycogenolysis".

Second prizes (100,000 roubles each) to:

Alexei Zavarzin, of the All-Union Institute of Experimental Medicine, for the study on the "Evolutionary Histology of the Nervous System".

Sergei Ognev, of the State University of Moscow, for the study on "Animals of the U.S.S.R. and Neighbouring Countries".

Economic Science

First prize (200,000 roubles) to:

Vladimir Komarov, president of the Academy of Sciences of the U.S.S.R., jointly with the following members of the Academy of Sciences: Ivan Bardin, Ergard Britske, Vladimir Obraztsov, Stanislav Strumlin, Lev Shevyakov, and Profs. Veniamin Veits, Nikolai Kolossovsku, Vassilii Kozlov, Boris Kuznetsov, Roman Pevzner, Abram Probst, David Chizhikov, and the scientific workers, Vladimir Galperin, Mikhail Rastsvetayev, Vyacheskav Rikman, Boris Gurevich, Ivan Doroshev, Mikhail Stekolnikov, for their joint work on the "Economic Development of the Urals in War Conditions".

Agricultural Sciences

First prizes (200,000 roubles each) to:

Johann Eichfeld, member of the Lenin All-Union Academy of Agricultural Sciences, director of the All-Union Institute for the Cultivation of Plants, for well-known works on the "Theory and Practice of Agriculture in the Extreme North of the U.S.S.R.".

Second prizes (100,000 roubles each) to:

Mikhail Dyakov, director of the Pushkin Zoo-Technical Laboratory, for works on the feeding of agricultural cattle and the elaboration of the foundations of the combined fodder industry.

Leonid Prassolov, member of the Academy of Sciences of the U.S.S.R., director of the Dokuchaev Soil Institute, for compilation of soil maps of the European part of the U.S.S.R. and elaboration of methods of calculation of land resources.

Medicine

First prizes (200,000 roubles each) to :

Alexei Abrikosok and Nikolai Anichkov, members of the Academy of Sciences of the U.S.S.R., for their studies on "Pathological Anatomy: Heart and Vessels".

Sergei Spasdkukopsk, of the Second Moscow Institute of Medicine, for well-known work in surgery and for the study "Actinomycosis of the Lungs".

Second prizes (100,000 roubles each) to :

Kolay Petrov, corresponding member of the Academy of Sciences of the U.S.S.R., for studies in oncology and the surgery of ulcers of the stomach and duodenum.

Sergeii Udin, chief surgeon of Sklifassovsky Institute, for his works "Notes on Field Surgery and Artificial Œsophagus", "Notes on Field Surgery", "Treatment of War Wounds with Sulphamide Preparations" and "Some Impressions and Reflections about Eighty Cases of Artificial Œsophagus".

Military Science

First prize (200,000 roubles) to :

Ivan Grave, of the Dzerzhinsky Artillery Academy, for the study "Ballistics of a Semiclosed Space".

Second prizes (100,000 roubles each) to :

Evgenii Barsukov, for the historical study "Russian Artillery in the World War".

Mikhail Dubinin, of the Voroshilov Academy of Chemical Defence of the Red Army, for studies in chemical defence.

History and Philosophy

First prize (200,000 roubles) to :

Vladimir Potemkin, Evgenii Tarle, member of the Academy of Sciences of the U.S.S.R., Vladimir Khvostov, jointly with a number of others for a work entitled "The History of Diplomacy".

Second prize (100,000 roubles) to :

Sergei Rubinstein, of Herzen Pedagodical Institute in Leningrad, for his book entitled "Foundations of General Psychology".

COSMICAL ORIGINS OF THE ELEMENTS

PROF. SUBRAHMANYAN CHANDRASEKHAR, assistant professor of theoretical astrophysics at the University of Chicago, described some results of his investigations of the origin and distribution of the chemical elements of the universe in a paper read during the fiftieth anniversary celebrations of the University of Chicago.

The formation of the lighter elements, including hydrogen and helium, can be accounted for at densities and temperatures not markedly greater than those found at present in the universe, but to account for the formation of heavier elements, such as oxygen, fluorine, neon, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine, argon, potassium and their isotopes, in their present relative abundance, more extreme conditions are necessary. For the formation of the quantities of these elements in anything like their present relative proportions, the density of a 'pre-stellar' universe of one thousand to one hundred thousand grams per cubic centimetre and temperatures of $6-8 \times 10^9$ degrees seem to be required.

Under such conditions, however, the very heavy elements, like gold and lead, occur only in very small amounts ; it thus appears that the pre-stellar stage must have originated at extreme densities and temperatures when the heaviest elements were formed. As the matter cooled to lower densities, the present relative abundances of the moderately heavy elements like silicon and sulphur resulted under conditions of a few thousand million degrees and densities ranging from one thousand to ten thousand grams per cubic centimetre. Finally, the elements lighter than oxygen were formed at a still later stage, when conditions were not very different from those now existing in stellar interiors.

In discussing the formation of energy in giant stars, Prof. Chandrasekhar stated that whereas the Bethe theory successfully accounts for energy production in the sun and similar stars, it fails to explain energy production in the giants. His own calculations show that the production of energy by the lighter elements, including lithium, beryllium and boron, will take place in a spherical shell rather than close to the centre—burning, so to speak, from the centre outward. The energy-generating spherical shell cannot get very far from the centre, leaving only the inner 35 per cent of the star's mass to provide energy ; this, he believes, accounts for the presence of the light elements in the atmospheres of the giants.

The theory that supernovæ constitute an intermediate stage in which extremely heavy stars cast off much of their mass in their 'attempt to settle down as white dwarf stars' was put forward by Prof. Chandrasekhar. He pointed to the analysis by Dr. Minkowski, of the Mt. Wilson observatory, of the central star of the Crab nebula, which was identified as the result of a supernova in our galaxy, which 'blew up' in A.D. 1054. His analysis of Dr. Minkowski's results showed that this nuclear star is half-way between the supernova and the white dwarf stage: thus, it will be a white dwarf by approximately the year 2828.

According to the theory of white dwarfs developed by Prof. Chandrasekhar, the upper limit to the masses of white dwarfs is about twice the mass of the sun. Thus, he said, a massive star may undergo great contraction, bringing about the explosion characterizing the supernova.

RECENT RESEARCH IN OCEANOGRAPHY*

By DR. G. E. R. DEACON

THE papers in the most recent number of the *Journal of Marine Research* of the Bingham Oceanographic Laboratory, Yale University, for 1941 cover a wide field.

R. B. Montgomery has used four series of observations across the Straits of Florida near Habana to compare the calculated difference of sea-level between the two sides of the Gulf Stream with the figure given by the tide-gauge readings at Key West. The agreement was poor, and among the main sources of error new emphasis is given to the distortion of the picture of the density distribution which is inevitable owing to the change of tide as

* Sears Foundation for Marine Research. Bingham Oceanographic Laboratory, Yale University. *Journal of Marine Research*, 4, No. 3 (1941).

the ship works her way across the strait—taking about sixteen hours to complete the section. Better agreement between calculations and tidal data has been obtained farther north along the U.S. coast, and it is suggested that the exposure of the tide-gauge at Key West is not altogether satisfactory.

G. L. Clarke has measured the water transparency and light penetration over a large area south of Bermuda as far as the coast of British Guiana. The waters of the Sargasso Sea and North Equatorial Current were clearest; there was less transparency in the more fertile waters nearer the equator and a sharp drop near the South American coast. The measurements were made with photo-electric cells and compared with observations of the depth to which a 'Secchi disk'—a white disk 20 cm. in diameter—could be lowered before it disappeared. The correlation showed a high degree of scatter, but on an average the disk disappeared at a depth where the illumination was 15 per cent of that incident on the surface. The greatest depth to which the disk was seen was 47 m.; the poor agreement with direct measurements is believed to have been due to unfavourable weather conditions and large waves; the disk was viewed directly over the ship's side and not through a tube dipped below the surface.

H. W. Graham has examined the plankton hauls made from the non-magnetic ship *Carnegie* on her last, ill-fated voyage from California to Samoa. The hauls, which were made from a depth of 100 or 150 m., showed a richer plankton in the tropical region, where there is evidence of the upwelling of deep water, than in the southern part of the temperate zone, where there is an accumulation of warm water with less nutrient salts. The author does not mention recent work by Seiwell and Riley, which has an important bearing on the subject.

F. A. Davidson and Elizabeth Vaughan, of the newly constituted United States Fish and Wildlife Service, describe their work on the relations between density of population, size of fish and time of spawning migration for the pink salmon of south-eastern Alaska. Between 1914 and 1920 while the fishery was expanding rapidly the fish declined in abundance, but increased in size and migrated to the rivers at an earlier date. After 1921, when restrictive regulations were introduced, the fish began to regain its former abundance, but decreased in size and migrated later. The authors summarize many influences which have been found to retard growth in a crowded population, such as the production of autotoxins, growth-inhibiting substances, accumulation of excretory products, reduction of available food, and over-stimulation due to increased contacts, but they are inclined to believe that the changes in the pink salmon are mainly the result of the varying competition for food as the population increases or decreases.

Mary Sears compares the phytoplankton productivity of the shallow water over the Georges Bank in the Gulf of Maine with that of the neighbouring deeper waters. It was found that the period of diatom abundance lasted longer in the shallow water; the deeper waters are as rich or richer during the peak period at the end of March, but become relatively barren at the end of a month, while the population of the shallow water falls to a twentieth of its peak value at the end of three months. The bank was thus found to be one of the most productive areas of the gulf.

C. E. ZoBell has combined the most desirable features of many bacteriological water-samplers to produce one which he claims to be non-bactericidal, easily sterilized and capable of aseptic manipulation under the usual collecting conditions. No metal was satisfactory and the containers were made of glass or indiarubber, sealed with a 4-mm. capillary tube attached by pressure tubing. The frame which holds the container is so arranged that the capillary is broken at a file-mark by sliding a 'messenger' down the wire on which the sampler is lowered. The indiarubber containers were used at the greater depths to avoid the effect of the sudden change of pressure on the bacteria when the sample was aspirated through the broken capillary; the containers were sealed hot and full of vapour, straight from the autoclave, and the indiarubber bulb was sent down in a collapsed state, to aspirate a sample as it returned to its normal shape. The possibility of exchange through the capillary while the sampler was being hauled to the surface was not thought to be serious: owing to the continuous reduction of pressure the main movement is outward.

SMOKE ABATEMENT AND RECONSTRUCTION

Many minds are turned to post-war conditions, when problems such as unemployment will coincide with opportunities for reform of layout and rebuilding of cities. The National Smoke Abatement Society has submitted to the Ministers concerned a memorandum on smoke prevention in relation to initial post-war reconstruction in Great Britain (Nottingham: National Smoke Abatement Society, 2*d*.).

The memorandum is concerned only with the prevention of smoke in the new building that will take place immediately after the end of the War. Provided that early attention is given to this question, it is considered that practically the whole of this building can be made smokeless.

The memorandum first proposes that the important principle be established of ensuring the use of suitable appliances and plant by requiring all new installations of fuel-burning equipment to have the previous approval of a special authority. By this method, which is common in the United States and elsewhere, both fuel economy and smoke prevention can be promoted.

The complete smokelessness, it is said of commercial buildings, that is, all premises other than industrial and domestic, may be readily achieved and should certainly be assured. Open fires should not be permitted in such premises except in special cases, when the use of smokeless fuels should be made obligatory. Industrial plant of all kinds is included in the proposals for the previous approval of new installations, and in many cases the control should also cover use and maintenance.

Much can be done to improve the standards of heating in domestic houses and flats apart from smoke prevention, but if the requisite attention is given to the problem in good time, it is likely that either the whole or a great part of the new housing could be made completely smokeless. The chief problem appears to be that of the supply of smokeless fuels suitable for open grates and other appliances, which must be correlated with the volume and rate of housing. This and other questions should be examined by a Government committee or board, which should include representatives of Government departments, fuel and appliance industries, and town planning, housing, and smoke abatement authorities.

Smokeless central areas should be established in all large towns. Not only should new premises in such areas be smokeless, but also powers should be given to enforce the smokelessness of existing premises. In this way the whole of the most important area of a town could be made completely smokeless.

Town planning schemes in general should include additional measures for ensuring smoke prevention, especially in relation to the zoning of industry and the establishment of special industrial areas or estates. The possibilities of district heating for all types of area should be fully examined and this method adopted wherever it is found to be advantageous. Committees, national, regional and local, concerned with post-war planning, should be assisted in their work by existing regional smoke abatement committees or others experienced in smoke prevention matters.

Support is given to the proposals that have been made in many quarters for the formulation of a comprehensive national fuel policy and for the establishment of a Ministry of Fuel.

It is a commonplace that post-war reconstruction offers great opportunities. So it was thought after the War of 1914–18, when a departmental committee of the Ministry of Health reported on the same question and commented that "the chief factor in the failure to deal with the smoke evil has been the inaction of the central authority"—to which might be added the local authorities. As the memorandum shows, this is a case where technical knowledge is in front of public and official opinion.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk is open to the public*)

Monday, April 27

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Mrs. Stephen Courtauld: "In the Netherlands Indies" (Kodachrome Films).

Wednesday, April 29

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. R. Fitzmaurice: "The Post-War Home", 10: "Lighting, Heating and Ventilation".

Thursday, April 30

INSTITUTE OF FUEL (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 2.30 p.m.—Dr. S. G. Ward and Mr. W. J. Morison: "Practical Application of Gas Producers to Road Transport including Passenger Service Vehicles".

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. E. J. Salisbury, F.R.S.: "The Weed Problem".*

Friday, May 1

GEOLOGISTS' ASSOCIATION (in the Geological Society's Rooms, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. V. C. Illing: "Geology Applied to Petroleum".

APPOINTMENTS VACANT

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

ASSISTANT MASTER (GRADUATE IN ENGINEERING WITH WORKS EXPERIENCE) to be responsible for the teaching of Engineering in the Consett Secondary School and Technical Institute—The Director of Education, Shire Hall, Durham (May 2).

PRINCIPAL OF THE WALKER TECHNICAL COLLEGE, OAKENGATES—The Secretary for Education, County Buildings, Shrewsbury (May 16).

HEAD OF THE CHEMISTRY DEPARTMENT—The Secretary, Robert Gordon's Technical College, Aberdeen (May 30).

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.), No. 49: Salmon of the River Erne: Results of the Examination of a Small Collection of Scales and Data. By Arthur E. J. Went. Pp. 471–480. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s*. [233

Geological Survey of Great Britain: England and Wales. Wartime Pamphlet No. 23: Jurassic Iron Ores, Cleveland District. By W. Anderson. Pp. 42. (London: Geological Survey and Museum.) 1*s*. 8*d*. [233

Freshwater Biological Association of the British Empire. Scientific Publication No. 6: The Production of Freshwater Fish for Food. By Dr. T. T. Macan, Dr. C. H. Mortimer and Dr. E. B. Worthington. Pp. 36. (Ambleside: Freshwater Biological Association of the British Empire.) 1*s*. 6*d*. [233

British Electrical and Allied Industries Research Association. Supplement to Reference A/T83: Mechanical Behaviour of Bitumen. By W. Lethersich. Pp. 8. (London: British Electrical and Allied Industries Research Association.) 6*s*. [243

Food Value Calculator. (London: Vitamins, Ltd.) 2*s*. 6*d*. [253

Year Book of the Royal Society of Edinburgh, 1940–1941. Pp. 100. (Edinburgh and London: Oliver and Boyd.) 5*s*. [94

Ovaltine Research Laboratories. Annual Report (1941). Pp. ii+4. (London: A. Wander, Ltd.) [94

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 2, No. 15: On the Estimation of Statistical Parameters. By Dr. A. C. Aitken and Dr. H. Silverstone. Pp. 186–194. (Edinburgh and London: Oliver and Boyd.) 9*d*. [94

Colonial Office: Colonial Development and Welfare in the West Indies. Agriculture in the West Indies. Compiled from Documents supplied to the West India Royal Commission, 1938–1939, and other Sources. (Colonial No. 182.) Pp. vi+280+16 plates. (London: H.M. Stationery Office.) 10*s*. net. [94

Bulletin of the Advertising Service Guild. Change No. 3: An Inquiry into British War Production, Part 1: People in Production. An Advertising Service Guild Report prepared by Mass-Observation. iv+145 galleys. (London: Advertising Service Guild.) 10*s*. [104

Other Countries

Presidencia del Gobierno: Dirección General del Instituto Geografico y Catastral. Anuario del Observatorio Astronómico de Madrid para 1942. Pp. 365. (Madrid: Instituto Geográfico.) [233

India Meteorological Department. Scientific Notes, Vol. 8, No. 98: Forecasting the 'Northeast Monsoon' Rainfall of South Madras. By V. Doraiswamy Iyer. Pp. 147–154. (Delhi: Manager of Publications.) 6 annas; 7*d*. [14

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 836-E: Local Overdevelopment of Ground-Water Supplies, with Special Reference to Conditions at Grand Island, Nebraska. By Leland K. Wenzel. Pp. iii+233–281+vi+plates 16–21. 30 cents. Water-Supply Paper 846: Natural Water Loss in Selected Drainage Basins. By G. R. Williams and others. Pp. iv+62+2 plates. 15 cents. Water-Supply Paper 852: Surface Water Supply of the United States, 1938. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. vi+293+1 plate. 35 cents. Water-Supply Paper 853: Surface Water Supply of the United States, 1938. Part 3: Ohio River Basin. Pp. vii+418+1 plate. 50 cents. Water-Supply Paper 855: Surface Water Supply of the United States, 1938. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. iv+350+1 plate. 35 cents. Water-Supply Paper 856: Surface Water Supply of the United States, 1938. Part 6: Missouri River Basin. Pp. viii+419+1 plate. 45 cents. Water-Supply Paper 858: Surface Water Supply of the United States, 1938. Part 8: Western Gulf of Mexico Basins. Pp. vii+355+1 plate. 40 cents. Water-Supply Paper 862: Surface Water Supply of the United States, 1938. Part 12: Pacific Slope Basins in Washington and Upper Columbia River Basin. Pp. vi+177+1 plate. 25 cents. Water-Supply Paper 865: Surface Water Supply of Hawaii, July 1, 1937, to June 30, 1938. Pp. iv+122. 20 cents. Water-Supply Paper 867: Hurricane Floods of September 1938. Pp. iv+562+20 plates. 1.25 dollars. Water-Supply Paper 886: Water Levels and Artesian Pressure in Observation Wells in the United States in 1939. By O. E. Meinzer and L. K. Wenzel and others. Pp. v+933. 1 dollar. (Washington, D.C.: Government Printing Office.) [74

Records of the Geological Survey of India. Vol. 76, Bulletins of Economic Minerals, No. 8: Clay. By Dr. H. Crookshank. Pp. 22. (Calcutta: Geological Survey of India.) 6 annas; 7*d*. [94

Erosion in the Cultivated Uplands of the North Punjab and its Cure. By H. M. Glover. Pp. 4+7 plates. (Lahore: Government Printing Office.) [94

Proceedings of the United States National Museum. Vol. 92, No. 3133: Notes on Two Genera of American Flies of the Family Trypetidæ. By John R. Malloch. Pp. 20. (Washington, D.C.: Government Printing Office.) [94

Smithsonian Miscellaneous Collections. Vol. 101, No. 10: Fauna Content of the Maryville Formation. By Charles E. Resser. (Publication 3676.) Pp. ii+8. (Washington, D.C.: Smithsonian Institution.) [94

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1941. Pp. iii+118. (Washington, D.C.: Government Printing Office.) 20 cents. [94

U.S. Department of Agriculture. Leaflet No. 212: The Sand Wireworm. By J. N. Tenhet. Pp. 8. 5 cents. Miscellaneous Publication No. 461: Revision of the Bark Beetles belonging to the Genus *Pseudohylesinus* Swaine. By M. W. Blackman. Pp. 32. n.p. (Washington, D.C. Government Printing Office.) [94