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PRODUCTION AND HOURS OF WORK

IN 1915 the Health of Munition Workers' Committee was appointed "to consider and advise on questions of industrial fatigue, hours of labour and other matters affecting the personal health and efficiency of workers in munition factories and workshops", and in 1918 the final report was published.

By means of *ad hoc* investigations and verbal evidence the Committee came to the conclusion that the long hours worked were detrimental to the health and efficiency of the workers, although they did not feel that they could definitely fix a limit for a suitable working week. Since 1918, much research work has been done and definite knowledge is now available that was lacking in 1918. For many reasons there has been a growing recognition of the importance of a reasonable working week. Before the present War some prominent firms had adopted the five-day week, and the necessity for adequate holidays and other aspects of industrial welfare had received much attention.

For research purposes the problem of hours had receded into the background, and investigations into less obvious environmental conditions, the effects of boredom, accident proneness, vocational guidance and selection, as well as problems of mental and physical health were conducted and published.

Apparently the lessons of the War of 1914–18 were not appreciated by the country in general, and so it has been necessary for the Industrial Health Research Board to publish a report* which has for its aim the consideration of some of the hindrances to maximum production in relation to the human effort.

The idea of man as a machine dies hard. For maximal industrial production there must be a regular flow of materials, the machines must be in perfect working order, and the worker of the machine must be in good health. For good health he needs, at least, adequate food, regular sleep, regular periods of leisure and reasonable conditions of work. Since the human being is not a machine he has the power to "rise above himself", to make himself by force of will produce more work than is his ordinary maximum. Hence the amazing success of emergency efforts. Unfortunately, those in authority often fail to acknowledge, except by lip service, the extraordinary as being extraordinary, and complain when the extraordinary gives way, as it must, to the ordinary. If a war were of a few weeks' duration, then little harm would be done by continued long hours, but when in this, as in the last, it is a question of years, then a steady output that can be regularly maintained is better than overwork followed by a steady decline.

This report shows the extraordinary efforts made by workers after Dunkirk. Throughout Great Britain, workers were stimulated by the state of emergency to make good the material losses incurred as a result

* Medical Research Council: Industrial Health Research Board. Emergency Report No. 2. Hours of Work, Lost Time and Labour Wastage. Pp. iv+26. (London: H.M. Stationery Office, 1942.) 6*d*. net.

of the collapse of France, and the effort was reflected in the production. The strength of the incentive, however, gradually waned, and fatigue and boredom could not be ignored. The time lost due to sickness, injury and absence without permission, when undisturbed by extraneous factors, varied with the weekly hours of work. It was usually reasonably low when the hours of work were less than 60 per week, but was higher and in some cases excessive when the hours were 65–75 per week. Unexplained absence of short duration rose with the increase of hours; this type of absence was due often to the desire for rest, or for a change from the monotonous conditions of the work. In almost every case holidays were followed by an increase in the rate of working. Labour wastage was high in some factories and particularly where large numbers of women unaccustomed to factory work were employed; domestic responsibilities, the difficulties of shopping and the problems of transport played a large part in this loss.

The findings resulting from the investigation suggest that over an extended period the weekly hours of work should generally not exceed 60–65 for men, and 55–60 for women. The report concludes with these words: "When it is remembered that many workers lived far from the factories, and had to face air-raids when travelling to and from work; that some had lost their homes and had to sleep in improvised shelters; and that often they had to wait outside in the cold and rain because of inadequate transport arrangements, the time-keeping of the factory personnel studied deserves high praise."

That the Government recognizes the importance of such investigations as those of the Industrial Health Research Board is already apparent from the announcement, recently issued, recommending that the customary annual holiday, with a break of one day on Easter Monday, Whit-Monday and August Bank Holiday and of two days at Christmas or the New Year, should be taken. By this means it is hoped to maintain the health of the workers and also to keep up production. Nevertheless, a scientific study of the many human problems of labour is as necessary now as in the War of 1914–18, and will be still more necessary after the War.

GEOLOGISTS IN WAR-TIME

THE support given by a modern State to geological studies usually takes the form of a Geological Survey, the functions of which are, broadly speaking, twofold: namely, to prepare and publish geological maps and generally to promote the study of geology, and to collect and record geological information of economic importance relative to mineral resources and water supply. The balance between the two aspects must be delicately held, and depends to a large extent on circumstances; thus in time of war, economic work will hold first place.

Great Britain is served by an excellent Geological Survey, which has been in existence for just over a hundred years. Its headquarters are at the new Museum of Practical Geology, South Kensington, and there are branch offices in Manchester, Newcastle-on-Tyne and Edinburgh. The staff consists of a relatively small band of highly trained geologists, whose activities take them to all parts of the country, either on routine work or to undertake special inquiries. Contact is maintained with geologists in universities and similar institutions, and with mining engineers and others specially interested. During its long existence the Survey has collected a vast amount of detailed information, much of which is unpublished, but is freely available for consultation at headquarters or in the branch offices. It might be thought that the very existence of such a centralized staff of trained workers would be sufficiently well known to ensure that full use would be made of their services in the present grave times, yet there is evidence that geological knowledge is not being utilized as it should be.

Prof. H. H. Read described the position very ably in an article in NATURE of January 10, p. 39. There he showed the high importance of geological studies for industry and for agriculture in locating new and substitute sources of mineral products. It may be pointed out that such sources are not only of importance in replacing supplies cut off by the spread of war, but also that whenever home supplies can be used to replace material formerly imported, there is a saving in vitally important shipping space. Geologists are also in a position to advise in connexion with the siting of camps, factories and underground storage and shelters, and we understand that a certain amount of consultation is somewhat belatedly taking place. Here perhaps the local geologist is also likely to have valuable knowledge. Nevertheless, there is no question that, in many cases geologists have not been consulted, with resulting waste of money and effort. Prof. Read also refers in his article to the remarkable results obtained during the past twenty years in the U.S.S.R. through the employment of thousands of geologists in mineral prospecting and development.

Turning now to the direct use of geology in the Armed Forces, it is of interest to note the position in the last war as described in "The Work of the Royal Engineers in the European War of 1914–1919. Geological Work on the Western Front" (Chatham: Secretary, Institution of Royal Engineers, 1922). In 1914, the Army had no geological establishment. Very soon, however, the need for expert advice in regard to water supply became apparent, and one geologist was appointed early in 1915. In May 1916, the Australian Mining Corps arrived in France, accompanied by the late Prof. (afterwards Sir) Edgeworth David, of the University of Sydney, who eventually became geological adviser on matters connected with military mining at G.H.Q. In 1916, Lieut. Loftus Hill, assistant government geologist of Tasmania, was placed in charge of special boring operations. Shortly before the Armistice was signed, further additions were made to the geological staff at G.H.Q., which eventually totalled five, in order to cope with the demand made by the advancing forces for geological maps. In September 1918, a proposal to form a definite Geological Establishment for the British Army was put forward but was too late to materialize. Throughout the War, constant touch was maintained with Geological Survey in Great Britain. Perusal of the book referred to leaves no doubt as to the multifarious uses of geological science during military operations, yet at the recent Conference on Science and the War Effort arranged by the Association of Scientific Workers (see NATURE, January 31, p. 130), it was stated that only two geologists are employed as such in the British Army.

According to the same book, the German conception of geological aid was different. Each 'army' appears to have had a definite military geological staff. In each 'corps' there were two professional geologists, with a draughtsman, clerk and boring party, attached to a field survey company, while a somewhat similar establishment, including, however, civilian research geologists, was attached to a survey company (*Landaufnahme*) apparently at army headquarters. The value of geological information was recognized in the American Armies. In 1917, Lieut.-Colonel A. H. Brookes, for many years director of the Geological Survey of Alaska, was made geologist, and a little later an assistant geologist was appointed. Finally, it was decided to increase the number of geologists with the American forces to seventeen, most of whom had been appointed before the Armistice was signed.

A certain amount of blame for the public neglect of geology lies at the door of geologists themselves. They have tended to keep their studies too much to themselves, though perhaps the very nature of their field work has separated them from other men of science. A larger portion of blame is attached, as Prof. P. G. H. Boswell showed in his presidential address last year to the Geological Society (see NATURE, April 19, 1941, p. 459), to the educational system of Great Britain, which during the past few decades has put a premium on the study of the physical sciences and thrust geology into the background. As a result, our administrators have little or no idea of the services geologists can render, and the general public has not the background of knowledge to enable it to appreciate the deficiency.

Prof. Read suggests, in the article referred to above, that the best use that can be made of the geologist at the present time is to let him carry on his geological work. To this we would add that steps should be taken to see that, whether he works as a civilian or is absorbed into the Armed Forces, his knowledge is exploited to the full in furthering the war effort. The Geological Survey does yeoman service in answering the numerous inquiries, many of which must involve lengthy and laborious investigations, sent to it by Government departments and others, and is producing a special series of War-time Pamphlets on mineral resources and water supply, but this is not sufficient. There must be more enlightened direction from above, to ensure that wherever geology impinges on human activity, in war or in peace, the contribution it can make is recognized without delay and appropriate action taken.

'UNCLE JOHN' BRASHEAR

John Alfred Brashear, Scientist and Humanitarian, 1840–1920

By Harriet A. Gaul and Ruby Eiseman. Pp. viii+220. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1940.) 14*s*. net.

IT is appropriate that the third volume in the series entitled "Pennsylvania Lives" should be devoted to John Alfred Brashear, a poor millwright with little education, who not only became famous the world over for his genius in the construction of fine precision instruments but also, through his untiring labours on behalf of the people of his native Pittsburg, became known to them affectionately as "Uncle John" and was voted "the most distinguished citizen of Pennsylvania".

Brashear acquired at an early age from his grandfather, Nathaniel Smith, a driving passion for astronomy. It was this passion that decided him to make a telescope so that others, and particularly children, should be able to see the stars, and to see them without charge. Working alone and with no one to advise or guide him, he undertook the construction of a 5½-in. refractor. He devised methods for cutting the glass into circular form and for shaping and polishing it, designing and constructing the necessary tools and plant. With no knowledge of optics he somehow, by intuitive skill, computed the requisite curves. After two years of labour in such spare time as his long hours at the mill afforded him, and with the able assistance of his clever and courageous wife, the objective was well on the way to completion when by an unfortunate accident the crown lens was broken. Nothing daunted, another disk was obtained and eventually Brashear's telescope was completed in the year 1875.

At this time S. P. Langley was director of the Allegheny Observatory, and Brashear, critical enough to be dissatisfied with what he had achieved, ventured with some trepidation to write to Langley for an interview and to submit to him his lens for criticism. Langley's advice to Brashear was to try a reflecting telescope with a silvered glass mirror, which would not require expensive optical glass and would involve the figuring of one surface only. Thus began an association which later ripened into the closest friendship and collaboration, in the course of which Brashear assisted Langley in the invention of the bolometer; successfully made for him prisms of rock-salt, after many others had tried and given up in despair; and helped him in his pioneer investigations in aeronautics.

Acting on Langley's advice, a 12-in. mirror was completed, only to split in half in an attempt at silvering by a process, taken from the *English Mechanic*, that required heat. A second mirror was completed; silvering by various methods which were tried proved uncertain and unreliable. At length, after much experimenting, Brashear devised the process that bears his name, which he published after he had tried it long enough to be sure it was infallible. With the 12-in. telescope, he devoted much of his leisure time to spreading his enthusiasm for astronomy among his fellow-workers at the mill and the children of the neighbourhood, by showing them the stars. Articles in the local papers helped to make him known in Pittsburg. To assist amateurs who desired to make their own telescopes he began in a modest way to make mirrors and eye-pieces. The work soon grew too much for a spare-time occupation, and at length Brashear resigned his position at the mill and devoted his whole time to the business of making instruments.

Through Langley, Brashear met William Thaw, the millionaire banker, to whom Pittsburg owed many benefactions and who had endowed the Allegheny Observatory. Brashear's enthusiasm kindled the interest of Thaw, who provided him with a larger shop and new equipment. Orders successfully completed for Langley, Michelson and Rowland enhanced his reputation for high-quality workmanship and his position as the principal maker of precision optical apparatus in the United States became established. Before long, the fruitful collaboration with the Warner and Swasey Company in Cleveland, Ohio, commenced; Brashear made the mirrors, lenses and spectroscopes for the large telescopes and mountings constructed by Warner and Swasey. Orders flowed in not merely from America but also from all over the world.

Science owes much to Brashear for the discoveries that the excellence of his instruments made possible; but what he accomplished in this way was only one side of his achievement. He was greatly interested in education and all cultural matters, and in the welfare of his fellow-citizens. Endowed with a vivid personality and tremendous enthusiasm, he became the intimate friend of the Pittsburgh millionaires, Thaw, Carnegie, Schwab, Frick and Phipps. Through his influence on them he was instrumental in the expansion of the Allegheny Observatory, the University of Pittsburgh, the founding of the Carnegie Institute and the Carnegie Technical Schools and the creation of the Frick Educational Commission. He became acting director of the Allegheny Observatory, when Keeler left to become director of the Lick Observatory, and raised large funds for a new observatory; the dedication in 1912 of this new observatory equipped with a 30-in. refractor and a lecture hall, open without charge to the public, realized one of the dreams of his youth. For some years he served as president of the Western University of Pennsylvania. The demands on his time for service on various boards were very heavy, but his life was essentially one of service to the community. One of his sayings was, "There is no room for the mean man in science". A great celebration was arranged for his seventy-fifth birthday, as a tribute to the high esteem in which he was held. A sonnet was written specially for this occasion by G. M. P. Baird, from which the following lines, which well describe Brashear's character, may be quoted:

> Heart of a little child, thought of a mage renowned,
> Simple of life and aim, humble in victory, crowned
> By loves that his heart made warm and truth that
> his soul divined.

This life of Brashear is sympathetically written and gives an attractive picture of a great personality. Unfortunately, the book contains many loose or erroneous statements and many minor errors. Space permits only a few to be mentioned. The description of the Foucault test on p. 55 is unintelligible; the statement on p. 78 that "what could be known of the position of the stellar bodies, their movements and distances from the Earth, had been largely solved by the first telescopes made in America" is grossly misleading. It is not correct (p. 180) that W. W. Campbell discovered the drift of the solar system through space; this was discovered by William Herschel. The statement (p. 183) that without Brashear's help few would have known how to use what he was capable of making is surely an exaggeration. On p. 194 Brashear is reported to have said, "If you would ride from the Earth to Alpha Centauri on a train, going at the rate of a mile a minute, it would take forty-eight years. We have an exaggerated sense of our own importance." This would place Alpha Centauri at about one quarter of the sun's distance from the earth. On p. 145 reference is made to a 60-in. object glass, in process of being made for the Lick Observatory: no object glass of this size has ever been attempted. There is peculiar confusion about the Astronomers Royal and the Royal Observatory, Greenwich; on p. 110 we are told that Sir James Dewar showed Brashear round the Royal Observatory; on p. 113 reference is made to "Sir William Huggins of the Royal Observatory in England"; on p. 183 Sir William Thomson is stated to be Astronomer Royal of England, while in Chapter 14, entitled "Steel Kings and Astronomers Royal", the only British men of science mentioned are Sir William Huggins, and Dr. John Tyndall, "one of the astronomers of the Royal Institute". On p. 117, when visiting Phipps at Knebworth, the Brashears were met "at the little station of Wellwyn, between London and Sheffield". Jannsen is spelt Jannsan and Galitzin is spelt Gallitzin. But perhaps the most glaring error to occur in a book about an astronomer is on p. 70; Brashear was one evening taking to Langley a mirror that he had silvered: "As he turned up the Observatory hill he looked over his left shoulder to the white crescent of the new moon rising above the city behind him. 'That's lucky', he said." A laconic comment for such a unique celestial event!

H. SPENCER JONES.

SHEARWATER LORE

Shearwaters

By R. M. Lockley. Pp. xii+238+20 plates. (London: J. M. Dent and Sons, Ltd., 1942.) 15*s*. net.

I THINK that this is the best of the many good books R. M. Lockley has written. So good is it, so full of careful observations set down in delightful prose, that I have limited my reading of the book to a chapter a night, for in each chapter there is much food for thought.

This book describes the habits of shearwaters on the author's own island of Skokholm, but in the summer of 1939 he and his wife travelled (like their shearwaters) far to the south, and he gives vivid descriptions of that visit—made just before the War broke out—to the Berlengas Islands, the Desertas and the Salvages. On the Salvages the travellers found colonies of frigate petrels nesting, small white-breasted blue petrels with long legs. That most delicate, fragile bird in flight resembled a huge mayfly. It flew above a sun-baked isle, on which the white surf thunders from the north wind that almost always blows here. The Salvages lie some 200 miles south-east of Madeira, and on the Great Salvage the nesting burrows on the crown of the island (p. 223) are occupied the year through by a succession of nesting birds. The holes are used from April until July by frigate petrels; from August until November by Madeiran petrels; and from December until March by the little shearwater. The author makes the lonely Great Salvage materialize in the reader's mind. How fortunate he was to have worked (and slept) among its delightful birds.

But I am lingering too long on these southern isles. The book is mainly about the shearwaters of Skokholm, and the author, ably helped by his tireless and enthusiastic wife, has done valuable work in testing the homing powers of these swift-winged birds of ocean and their incubation and fledging periods. He discovered that the parents (p. 32) habitually take incubation shifts of three to five days, and (p.35) that the incubation period is 52 days, or almost seven and a half weeks. By careful observations (p. 53) he ascertained that the fledging period of the young bird is 73 days and that, like the young of the storm petrel, it is deserted by its parents some days before it makes its way, unaided, from its burrow to the sea. On occasion a shearwater would continue to brood its egg, without food or relief, for a much longer period than five days. One of the birds nesting beside the author's house on Skokholm, which he named Adam, once brooded the single white egg for ten long days and nights in the burrow without being relieved by his mate. But when she took over, Aida (the mate) gave him a good spell of freedom, for she in her turn brooded for seven days without relief. Adam then brooded the egg a further nine days, losing in that time 2 oz. in weight.

From ringing experiments the author gradually realized the astonishing fact (p. 126) that the shearwaters of Skokholm actually fly to the Bay of Biscay to feed during their days off duty. That double flight in a straight line is 1,200 miles, but is well within the power of so strong a flier as a shearwater. This interesting discovery puts me in mind that I have often seen shearwaters on summer days moving south through the Sound of Mull. These, I take it, are birds which are nesting on Eigg, and it is not beyond the bounds of possibility that they too have their feeding-grounds in the Bay of Biscay.

It is no wonder that the young shearwater grows slowly, for the author has proved by experiment that on moonlight nights (it is never fed by day) the parents do not visit it. In very fine clear weather it may therefore go hungry for the best part of a week.

The recovery of various birds in Bay of Biscay waters at a time when they were actually nesting on Skokholm makes interesting reading. One of the most remarkable records (p. 124) was the discovery of a ring in the stomach of an angler fish weighing 40 lb.

The homing experiments were begun on a small scale. A shearwater from Skokholm was released at Start Point at 2 p.m. one summer day. At 11.45 p.m. the same night the bird was brooding its egg on Skokholm—and the egg was warm. That flight was a distance in a straight line of 225 miles. In Chapter 14 the author describes how he later took with him two shearwaters from Skokholm and released one 100 miles south of the Faroe Islands, the other just off those islands. When he returned to Skokholm he found both birds in their burrows, roughly 700 miles to the south. But the most remarkable homing feat was accomplished (p. 178) by a shearwater which was liberated on the shore at Venice (it had been sent by air) and returned to Skokholm, a distance of 3,700 miles by sea, in 14 days. The author seems to think it more likely that this shearwater returned overland for a part of the distance, but my own belief is that it must have kept to the sea throughout. To the shearwater, as to the gannet, the ocean is its home, and to travel over hill and plain, far from any feeding-ground, would be, I submit, foreign to its nature. I feel confident that the bird travelled by sea throughout. That is a remarkable flight: 500 miles south-east down the Adriatic, then south-west to the Straits of Messina, thence west to Gibraltar and north to Skokholm.

Since the shearwater's home is the sea, I think, therefore, it is not surprising that the majority of the birds released on the Alps (pp. 183, 184) in the summer of 1939 failed to make their way back to Skokholm. That the shearwater is a good flier even from the first is proved by the feat of a nestling which, ringed on Skokholm on September 3 before it had tried its wings, was discovered (p. 138) three days later on the coast of France.

On p. 49 there is an interesting account of how shearwaters at night climb a rock in order to 'take off' into the wind, "using legs, wings, and hooked bill, all three, to get to the top". Many birds, using the rock in this way for many generations, have worn a grove in the soft sandstone.

This book is a rare combination: exact scientific record combined with enthralling narrative written in simple, vivid English. Here is (p. 142) a literary gem:

"It had been a brilliant day with a strong north-west breeze against which a migration of swallows struggled northwards across the island, their white breasts skimming low over the yellow primroses, the white sea-campion, the first bluebells, and some early sea-pinks. A peregrine falcon, which for days had been attacking the small birds and the puffins, rose upon the wind vertically, and climbing higher and higher, dwindled and vanished against the infinite blue of the sun-filled sky. Towards evening heavy rain clouds came up out of the west and covered the setting of the young bow of the new moon. The wind eased and the whole sky became suddenly dark. That night was black and starless, and full of shearwaters."

I like, too, his description (p. 6) of the calling of oyster-catchers as a "whickering". That exactly describes the sound.

The book is well illustrated, and is one which will transport the reader, however much he may be engrossed with the cares of these grim days, to the restful beauty of Nature, ever-changing and ever-young.

SETON GORDON.

MEDICAL THEORY AND PRACTICE

The Advancing Front of Medicine

By George W. Gray. (Whittlesey House Publication.) Pp. viii+425. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 3 dollars.

THE medical man who is called in to treat disease is, in most cases, faced with a well-nigh impossible task. He is asked to remedy the defects of an organism, the normal working of which he does not understand. He cannot understand its working until, for one thing, chemistry and the application of chemistry to physiology have advanced further. It is the expedients and ingenuities used and the successes achieved in this task of treatment that Mr. Gray describes; with enough about the nature of diseases to make his description intelligible.

His account of recent advances is vivid and well balanced. For example, in the chapter on cancer he insists that the type of treatment must vary with conditions; he holds up no treatment as a panacea, but points out that any wholly satisfactory treatment must depend on a fundamental understanding of the nature of cancer. He indicates the wide range of medical research, from vitamins to brain potentials, from the inheritance of hæmophilia to the cycle of the virus of swine influenza, through lung worms and earthworms. But would a layman, reading this book, realize what difficulties have been overcome or how much success has been a matter of lucky shots?

One of the most spectacular achievements has been the discovery of the sulphonamide drugs. The difficulty has been to find something that will kill bacteria, once established in the body, without injuring the even more vulnerable host. Specific antisera, one of the natural defences, seemed promising; but, on the whole, they have been disappointing. First it had to be learnt that antisera, to be effective, must contain certain antibodies against the right constituent of the right type of the species of bacteria incriminated. Even now, with these requirements satisfied, it needs statistical analysis to prove the efficacy of sera in the treatment of pneumonia. It might seem possible to make some synthetic chemical with specific actions similar to those of antisera; but our chemistry is not yet advanced enough to solve the secret of these specific actions. So chemists have synthesized drugs in the hope of finding one that is effective; pathologists have tested them on animals and if they seemed successful they have been handed over to physicians to try on human patients. In this process the chemists of the I. G. Farben-Industrie made an azo-dye from *p*-aminobenzene-sulphonamide and handed it to Dr. Domagk to test on animals. Domagk found that the dye protected mice against streptococci. Human beings were then treated with remarkable success. Later it was found that the sulphonamide half of the dye alone was active. The development of this drug has not been based on theory; theories have limped far behind the discovery.

It was Whipple's demonstration that liver is particularly effective in curing anæmia, produced by bleeding, that led Minot to try the use of liver in the treatment of pernicious anæmia. But it seems that the effect on pernicious anæmia is entirely different from that found by Whipple; Minot could not have inferred the amazing cure of pernicious anæmia from Whipple's experiments. It was a lucky shot. As for the shock treatments of schizophrenia, they have much the same theoretical basis as the treatment of a watch by poking with a pin.

This insistence on the importance of appreciation of fundamentals does not imply any underestimate of the value of treatment or of the difficulties that practising physicians and surgeons must overcome. But, without this appreciation, it is not possible to realize the tremendous odds against which the medical man puts up a gallant fight. Mr. Gray's long list of brilliant partial successes may lead people to expect too much, too soon. Could he not have shown how much his front-line fighters are handicapped by lack of supplies and support from the rear in the form of fundamental theories on which treatment can be based?

A few of the faults inevitable in a compilation of this type have crept into the book. Some of the names quoted carry little weight; tuberculin is not a serum; the amounts of vitamin B_1 in meats (p. 45) are incorrect; Prof. J. Mellanby is not "of Oxford".

AN ORIGINAL APPROACH TO THE PROBLEM OF TUMOURS

The Problem of Tumours

The Application of Blastogenic Agents to Ciliates; a Cytoplasmic Hypothesis. By J. C. Mottram. Pp. vii+91. (London: H. K. Lewis and Co., Ltd., 1942.) 7*s*. 6*d*. net.

THE first part of this book deals with changes in form and behaviour of ciliates exposed to agents which increase or decrease the viscosity of the cytoplasm. A wide variety of physical and chemical agents cause similar effects, and, apparently, anything which makes the cytoplasm more viscid tends to inhibit complete fission, so that multinucleate cells are formed. Among other agents, the carcinogenic hydrocarbons can produce this result and thus give rise to clones of abnormal cells. Smaller doses have the opposite effect, and cause increased rate of division, but no recognizable abnormality in the daughter cells. A short review of the literature on abnormality in Protozoa is included. The important point is made that once abnormality has been induced, it may be perpetuated in the absence of the inciting agent.

Another point of greater interest is, that only a small proportion of ciliates in a culture react by recognizable abnormality, but that these cells can transmit the tendency to abnormality indefinitely: whether the abnormal cells overgrow or are overgrown by normal cells in mass culture depends on their relative rates of fission.

These and many other experimental observations are adduced by Mottram in support of the contention that the behaviour of these abnormal Paramecia is analogous to that of tumour cells in mammals. Having presented these facts, he invites the reader to answer this postulate for himself, but makes it clear that he thinks the answer should be affirmative. The gene mutation theory of cancer is briefly discussed and dismissed by arguments which appear to the reviewer to be feasible but not conclusive. A short account is given of an interesting chance infection of a culture of Aspidisca by an unidentified virus, which could be recognized as inclusion bodies in the cytoplasm, and which gave rise to abnormalities in morphology and behaviour similar to those induced by blastogenic agents. Unfortunately, the disease was fatal, and attempts to recover the virus and to infect new cultures failed.

Despite the obviously great differences between unicellular animals and the tissues of mammals, Mottram has assembled a remarkable number of analogous findings in the behaviour of these cells under a wide variety of adverse conditions. He anticipates the criticism "that to draw analogies between the reactions of Protozoa and Metozoan cells is fallacious"; but, whereas these analogies are based on observed facts, some of the assumptions in the postscript are much more open to criticism. However, the author is careful to keep his facts distinct from his theories, and his account of a most original approach to the problem of tumours will be enjoyed by most research workers.

The text is freely illustrated with excellent black and white drawings, and a photographic frontispiece, and there is a bibliography of 103 references.

P. R. PEACOCK.

The Birds of the Liverpool Area

By Eric Hardy. (Merseyside Naturalists' Association Handbooks, No. 1.) Pp. 279+10 plates. (Arbroath: T. Buncle and Co., Ltd., 1941.) 8*s*. 6*d*. net.

FIELD ornithologists will appreciate this publication, first for bringing within the confines of a single volume a mass of records hitherto scattered among numerous publications, and secondly for its list of localities where the bird-lover, month by month, can view many of our common species. Part of the preface could, with advantage, have been omitted, as the author devotes it to criticisms of local societies, inappropriate to any scientific work. There is a brief list of local ornithological collections and a short account of Wild Bird by-laws.

The opening paragraphs of the chapter on "Bird Movement and Migration", while containing much that is useful and interesting, are likely to irritate the reader by obscurity of presentation. The chapter on "Bird Census" is not convincing and the author's figures are unbelievably accurate. On p. 48 he states: "The Liverpool Census for 1935 showed 95,000 House-sparrows, 27,000 Starlings, 1,680 Wrens, 1,310 Greenfinches, etc." Ornithologists who have essayed a bird census, even in a relatively small area in the country, know how difficult it is to arrive at a satisfactory assessment. A census of starlings or sparrows in a large city such as Liverpool will be regarded by most competent ornithologists as unreliable. In compiling the hundred pages of notes on the birds of the Liverpool Area much painstaking search of records must have been involved, but the author's own work would not have suffered by less frequent reference to himself. The volume is illustrated with two maps, one sketch and thirty-one photographs, of which those of the long-eared owl and the lapwing in flight are indeed good. R. K. PERRY.

Transients in Electric Circuits

Using the Heaviside Operational Calculus. By Prof. W. B. Coulthard. (The Specialists' Series.) Pp. viii+203. (London: Sir Isaac Pitman and Sons, Ltd., 1941.) 25*s*. net.

IT has been said by an eminent American engineer that whereas problems in transient phenomena can only be solved by the application of the calculus, the terrors which this branch of mathematics holds for many engineers have largely been removed by the substitution of the Heaviside operational calculus. Transients may be controlled or fortuitous, but in either case the transient response of a network to excitation can be solved expeditiously and with minimum labour by the technique which has been built up around Heaviside's original methods.

The book under review presents a modern version of this technique in its application to the study of electric circuits consisting of static networks, rotating machines, and component structures. Circuits having both linear and variable parameters are analysed, as well as those which can be regarded as lumped on one hand and in which expansion yields negative powers of the differential operator p, and smooth on the other hand, wherein expansion gives fractional positive powers of p.

Fourier series and integrals are discussed in order to throw further light upon operational methods and to show that the integral yields a long list of operators and their equivalences.

The book is a particularly valuable one to the research worker and to the mathematically inclined engineer.

Nature Abounding

Edited by E. L. Grant Watson. Pp. 350. (London: Faber and Faber, Ltd., 1941.) 10*s*. 6*d*. net.

EARTH, air, fire, water, these were the elements as conceived by the philosophers of other days, and under these heads Mr. E. L. Grant Watson, in the present work, has assembled an unusually readable and varied prose selection, representative of the interest with which Nature, to the seeing eye, abounds. He has chosen widely and well. Nature's appeal is for the many, and the compiler has sought his materials, not only in the writings of professed naturalists, explorers and physicists, but also among those of sportsmen, novelists, essayists, gardeners, farmers, and, not least, of the ordinary man. Thus passages from Darwin and Wallace rub shoulders with not less informed observations by Hardy the novelist, Tomlinson the sympathetic voyageur, or Borrow the wayfarer. As he turns the pages, the reader will meet many old and expected friends: Fabre, Hudson, Herman Melville, Izaak Walton and others, and among newer ones, Frazer Darling, Kenneth Graham and Sir James Jeans, to take only a few at random.

The knowledgeable reader, with critical intent, may perhaps peruse this book with the view of testing the compiler's selection against his own recollection of outstanding passages in classic works. Of course, he will find omissions and an unwelcome abbreviation of his own particular favourites, but as Mr. Grant Watson points out, the literature of exploration, travel and natural science in its several branches is so extensive that there can be no question of compiling a complete work. But books of this nature are all too rare, at least so far as the literature of science is concerned, and it seems not impossible that they may have a considerable future, particularly for the specialist worker whose time for general reading is necessarily limited. More is the pity that war-time conditions should condemn such noble text to such indifferent paper.

Oriri

By Marie C. Stopes. Pp. ix+27. (London and Toronto: William Heinemann, Ltd., 1940.) 3*s*. 6*d*.

THIS considerable poem has already been reviewed, and favourably reviewed, in various literary journals. It is the love story of a man and a woman in a setting in which objects of Nature, earth, trees and flowers, are harmonized to the central theme. In the Argument, the author tells us that: "Interwoven into the tale is a crystallization of most of what matters fundamentally in the sciences of geology and physiology, in the art of love, and in religion." The poem has indeed a scientific content, but so pervading is the artistic sense, so effective the condensation, that the work, which may well be considered as briefly epical, makes its appeal, as the author intended, as poetry.

"Time's sands shine dripping over
With burdens of delight
Garnered from all the past:
Again the bright sea sparkles on this hill
And slowly specks of life shed through its blue
Their fragile vestures, piled to build a land."

Not the least unusual feature of this remarkable work is the brief appendix in which the scientific basis for the imagery used is indicated.

INDIVIDUALITY AND SCIENCE*

By DR. A. F. BLAKESLEE
Director, Cold Spring Harbor, New York

IN looking over my past research activities, the one idea which impresses me most is the individual diversity among living organisms. Our first published investigations had to do with a group of lower fungi which can be included in the name of bread moulds. Among these we discovered that growths which looked alike might differ in sex and in a wide range of chemical responses.

Another example of cryptic chemical differences was furnished by the black-eyed Susan (*Rudbeeckia hirta*). Two races which had yellow instead of purple cones we found could be distinguished by use of strong potash solutions. The treatment turned the cones of one race black and those of the other red.

These examples have to do with innate differences between individuals. Let us consider some examples of differences in which the environment appears to be the controlling factor. One variety of corn has red kernels at the ends of the ears where they are exposed to the sun but white kernels where they are covered. Both the red and the white kernels when planted, however, gave the same kind of offspring. What was inherited was the capacity to become red in a light environment and white in a dark environment.

I used to ask my students to find two apple leaves which were alike. They would start with enthusiasm, but soon would come to realize that two leaves exactly alike could not be found if one used as a simple criterion of identity the possibility of having the two leaves match with all their indentations when one was superimposed upon the other. I would point out that the general pattern of the apple leaf in distinction from that of an oak, for example, was due primarily to its hereditary constitution but that the wide variations in size and shape of leaves and the arrangement of teeth on their edges were modifications of the pattern induced by differences in the environment such as the position of the developing leaf in relation to light and shade, vigour of the twig, its position in the developing bud and other possible factors in internal environment.

With these considerations in mind it is not difficult to realize that probably no two trees in orchard or forest can ever be exactly alike, since in addition to the modifications brought about by variations in environment we have the modifications brought about by differences in hereditary constitution.

Although we can influence the character of organisms through the environment, it is generally believed that we have no control over their heredity. This is not entirely true.

Records this month on seedlings of jimson-weed which had grown from seeds buried for thirty-nine years in soil at the U.S. Department of Agriculture in Arlington seem to be showing an increased rate of mutations. We cannot predict, however, the exact types of hereditary changes that will be induced by ageing and other stimuli. In some cases in the jimson-weed, however, we have used mutated chromosomes with which to synthesize new pure-breeding types with predicted characteristics. By attention to the total number of their chromosomes we have reduced their ability to hybridize with their parental types and hence feel justified in calling them synthesized new species.

By one method we have succeeded in exercising conscious control over heredity, and are able to predict with reasonable accuracy the characteristics of the new types induced through doubling their chromosome number by means of colchicine. In our own and other laboratories new species have been produced by doubling the chromosome number of sterile species hybrids, and new species are known to have been produced by this method in Nature.

In many biological problems affecting human beings, science has had to look to botanists to lead the way. I need to remind you only of the original discovery of the mechanism of heredity by Mendel from his work on garden peas and its later independent rediscovery by three botanists. My interest in human individuality came from my experience with plants. It all started from a botanical problem in 1917 when we were trying to classify the colours of a segregating pedigree of Verbenas. A particular pink-flowered form was very fragrant to me but had absolutely no odour to my assistant. On the other hand, a certain red-flowered Verbena was fragrant to him but not to me. Some of the people in our laboratories agreed with me and some with my assistant. Only a very few found fragrance in both kinds of flowers.

Phenyl-thio-carbamide is a good reagent with which to show innate differences between people. Some of those we have tested need to have the solutions of this reagent more than eight thousand times as strong as others in order to taste it. The inability to taste the commercial crystals is inherited like blue eyes as a Mendelian recessive character; but different grades of taste acuteness have also been shown to be inherited. Numerous tests with other substances only emphasize the wide differences between people in their taste reactions.

The individual reactions of taste are dependent primarily upon innate hereditary factors, and the environment appears of relatively little importance. With smell the condition is quite the opposite. Probably even wider innate differences exist between people in their acuteness of smell than of taste, but environmental factors in abundance prevent the full expression of these hereditary differences. Thus age is a potent factor progressively dulling the sense of smell. A considerable number of people have lost their sense of smell entirely. Temporary conditions of a person, such as a cold in the head, may adversely affect his ability to smell. After being exposed to an odour for a time it becomes no longer perceptible. Olfactory fatigue apparently may be produced even by concentrations too weak to be detected. This is probably the explanation of asphyxiation of people by gradually increasing concentrations of gas which they never detected.

The sense of smell does not play as important a part in man as in many of the lower animals in bringing us information about the external world. There is not a negligible number of people, however, who can distinguish different individuals by odour in the same way in which dogs can distinguish individuals by scent alone. This power is more frequent in children but is often retained into adult life when it is generally concealed on account of the social taboo against speaking of personal odours. Several parents have informed me that certain of their children when young by smelling a handkerchief they had picked up could tell to which member of the family it belonged, but this ability had been lost after they had grown up.

*Substance of the address of the retiring president of the American Association for the Advancement of Science, delivered at Dallas, Texas, on December 29.

Associations are especially powerful with the sense of smell, but they exist with all the senses. So long as we live we are building up associations and developing our personality through reactions with our environment which express themselves in likes and dislikes. Likes and dislikes are important determiners of our behaviour.

The examples just given of the influence of heredity and environment have been taken from the senses of taste and smell. All the other senses are similarly subject to internal and external influence. I need only mention the innate differences in musical discrimination disclosed by Seashore and the progressive decrease, under the environmental influence of age, in the pitch or number of sound vibrations one can distinguish at a given intensity. There are a host of other responses which contribute to human individuality. Among these are the blood groups, the natural and acquired susceptibilities and immunities to disease and chemical substances, the allergies and the reactions to hormones and vitamins. The Binet and other mental tests have disclosed great differences between individuals in mental equipment.

cases, by a majority of only one. With its broadly changed complexion since early New Deal days, one might expect less diversity in judgment at the present time. This does not seem to be the case judging from a recent news report of the first two decision days of the present term. Within two weeks there were brought in three 5-to-4 and two 6-to-3 decisions. None of the justices during this time had failed to enter at least one dissent and all except two had more. We cannot here attempt to analyse the elements in these differences in judgments. Such blanket terms as liberal and conservative suggest the influence of innate disposition and also of such environmental factors as advancing age. If we remember our experiments with taste and smell we may agree that judgments of drinkers regarding the taste of beer and judgments of the Supreme Court regarding issues of law cannot help differing because men both are born different and have differences thrust upon them by their environment.

Differences in expression in art, music and literature can likewise be attributed to influences of heredity and environment. I have personally been interested in studying the manner in which trees have been used in art. Styles in method of representation are evident, but the artists differ in the way in which trees appeal to them. Some are interested in individual trees, others in groups. Some prefer trees in the foreground, others in the background or in the middle distance. There are differences also in the species of trees which different artists like best.

VOTES FOR TITLES IN RELATION TO POSITION ON BALLOT, LANCASTER, PA., JANUARY 30, 1941

	Titles	Position on Ballot*					Total votes	Per cent of total	Rank
		1st	2nd	3rd	4th	5th			
Males	Why people differ	2·08 A	5·26 E	5·26 D	7·69 C	9·26 B	15	6·02	4
	Differences between people in taste and smell . .	44·4 B	70·83 A	63·16 E	59·65 D	69·23 C	152	61·04	1
	What makes differences in personality	1·92 C	14·81 B	6·25 A	5·26 E	8·77 D	19	7·63	3
	Demonstrations of heredity and environment ...	3·51 D	3·85 C	11·11 B	4·17 A	2·63 E	13	5·22	5
	Why each person lives in a different world ...	23·68 E	22·81 D	17·31 C	20·37 B	16·67 A	50	20·08	2
	Total number	37	59	45	53	55	249	99·99	
	Per cent	14·86	23·69	18·07	21·29	22·09	100·00		
Females	Why people differ	8·70 A	2·17 E	10·53 D	9·30 C	8·57 B	16	7·69	3
	Differences between people in taste and smell . .	62·86 B	47·83 A	65·22 E	57·89 D	60·47 C	122	58·65	1
	What makes differences in personality	4·65 C	... ... B	10·87 A	4·35 E	7·89 D	12	5·77	4
	Demonstrations of heredity and environment ...	5·26 D	 C	5·71 B	6·52 A	10·87 E	12	5·77	4
	Why each person lives in a different world ...	17·39 E	18·42 D	25·58 C	22·86 B	26·09 A	46	22·12	2
	Total number	38	30	52	39	49	208	100·00	
	Per cent	18·27	14·42	25·00	18·75	23·56	100·00		

*Five titles were listed in different orders on five ballots A to E.

Numbers under each position are percentages of votes cast for given title on the ballot indicated by letter at right of figure.

Males: Ballot A was voted 48 times; B, 54 times; C, 52 times; D, 57 times; E, 38 times.

Females: Ballot A was voted 46 times; B, 35 times; C, 43 times; D, 38 times; E, 46 times.

It will be granted no doubt that there are great differences between people in their sensory judgments regarding the world in which they live and that these differences are influenced in varying degree by factors of both heredity and environment. Is this true of man's mental and spiritual judgments? I believe it is even more so. A few simple examples may be given.

At the end of a meeting held at Lancaster, Pa., the audience was asked to select the best title among five which had been suggested for the lecture just given (see table). It might be thought that since all had heard the same lecture, there would have been considerable unanimity in preference. This was not the case, however. Though two titles had more votes than the others, each of the five titles was preferred by a considerable number. Here again we may be reasonably sure that factors of both heredity and environment did influence the mental judgments regarding the best title.

The Supreme Court of the United States is composed of outstanding minds. Their honesty is unquestioned, and they are freed from even the unconscious pressure of political expediency. Here, if anywhere, we should expect unanimity. The Supreme Court, however, from its early history had rendered numerous decisions by a divided vote and in many instances, including some of the most important

We have given examples of differences in plants and animals such that no two individuals are exactly alike and have classified the causes of these differences into the interacting factors of heredity and environment. We have shown that both heredity and environment are likewise responsible for the diversities in man, not only in his physical structure and sensory reactions but also in his mental and moral judgments. Every thought and act of our lives is influenced by these two factors. Man has used his knowledge of heredity and environment to mould plants and animals to his personal advantage. Can this be done with man himself? To some extent, yes, but the way is not so clear.

I know of no adequate evidence that man to-day is a better animal physically or mentally than at the dawn of history. While man's biological evolution during these five thousand years and more has seemed to lag, and at the present time has appeared to many to have been thrown into reverse, man's environment has changed markedly even within our own lives. Conscious control of human heredity, though a desired goal, will at best be slow even if our genetic knowledge were adequate for the task. Changing man's environment gives promise of more rapid betterment of human individuals, and in this effort we are far from reaching diminishing returns.

But the facts of individuality and the relative influence of heredity and environment upon personality must be carefully estimated in any rational campaign for permanent social betterment. Such knowledge has power to revolutionize our ideals and practice in social and religious justice, charity and education, methods of legislation and forms of government. Methods of education, for example, have been severely criticized for mass regulations which fail to take adequate account of individual excellences. Similar criticisms come from the so-called exact sciences, mathematics, physics and chemistry, against the difficult, less exact biological sciences, botany and zoology, and some would even deny the name of science to those most difficult studies of man's social behaviour. For years the educational world has been struggling with the problem of how best to deal with the increasingly recognized differences in mental ability, differences which, like those we have found in taste reactions, are of two kinds: a difference between general marked ability and general mediocrity and a difference between ability in certain lines such as mathematics, science, art or literature.

I recently wrote to the sixteen living past presidents of our Association and asked them if they could satisfy the enclosed New York State requirements for teaching in the State secondary schools. Not one of the past presidents of the American Association for the Advancement of Science would be allowed to teach science in a New York high school without further preparation since none had taken the required instruction, which included such subjects as the psychology, history, philosophy, principles and practice of education. One past president properly remarked that not all presidents would have been good secondary school teachers. It is a fact, however, that more than a quarter have had secondary school teaching experience, but could not now qualify under present requirements. This is not at the present time a serious deprivation of the freedom of these men, but some believe the State methods of selecting teachers place undue emphasis upon relatively unimportant requirements. Some educators have told us that in the balance between method and subject-matter they believed the pendulum had swung too far towards method.

Blanket regulations may make for ease of administration, but too great uniformity may preclude the assets of individuality. Uniform laws throughout the States would have certain advantages, but they might not be equally well adjusted to local environments and might prevent profitable experiments in local government. The increased means of communication throughout the world appear a mixed blessing. They tend to standardize our thoughts and behaviour in a common mould, but at the same time to decrease the material expressions of individuality available for social evolution through natural selection.

Opposition to totalitarianism is not merely because it attacks man's rights but also because it suppresses his personality. Individuality is the kernel of democracy, the biological basis of the struggle for freedom. When we fight for individuality we fight on the side of Nature. Recognition of individuality and all that it implies especially concerns us as men of science. Even if science were again persecuted and driven under cover, as it was in the Middle Ages, there would still be some brave inquiring minds. But science cannot flourish without freedom of thought and its expression.

Why do I emphasize the value of individuality to science? Because I believe science is the great hope of mankind.

In speaking of science and men of science it should be clear I am not confining attention to the professionals. Whoever by observation or experimentation is responsible for increased knowledge of the world in which we live is a servant of science and contributes to the welfare of mankind. In this connexion it is appropriate to mention that in Colonial times keen observers had discovered the causal connexion between barberry bushes and infestations of wheat rust and had passed laws in Massachusetts for the eradication of barberries long before botanists learned that a necessary stage in the life-cycle of this rust is confined to the barberry.

Science is under fire for the suffering brought about by its applications, especially in the present war. Science is in no position to disavow its responsibilities in the problems of peace and war. As in epidemics of disease due to ignorance of medicine we need not less but more medical knowledge, so in seeking a cure for the scourge of war we need not less but more science. The remedy we trust may ultimately be found by that most difficult of all biological sciences—the study of motives and human behaviour. Science can reply to its critics that the applications of science are merely tools which men with good or bad motives use for their good or evil ends. The same can be said of printing. Even if we admit the responsibility of science for deaths due to its applications we will find that its applications have brought about even greater savings of life. The legend to a reproduction of the title page of Jenner's paper on vaccination published in 1798 reads: "The application of the facts presented in this paper has probably saved more lives than the total of all lives lost in war." The statement is easy to believe, since it has been estimated by Haggard that in the hundred years preceding Jenner's paper, sixty million people in Europe died of smallpox.

In war itself science has not been alone destructive, as may be seen from figures supplied by the Surgeon General's office regarding the annual death-rate per thousand in the United States Army for the Mexican War, the Civil War and the first World War. Deaths due to battle injuries increased from 15 per thousand for the Mexican War through 33 for the Civil War to 53 for the World War. The death-rate due to disease, however, decreased from 110 through 65 to 19 for the World War. The net result is that the total death-rate actually declined, from 125 in the Mexican War through 98 in the Civil War to 72 per thousand in the World War. It is a satisfaction to feel that though implements of war have increased in destructiveness, those who are fighting to preserve our free way of life may not be subjected to greater risks than our forefathers assumed when they too fought for their country.

It can scarcely be emphasized too strongly that it is not man's material comforts nor even the alleviation of his physical pains which are the greatest gifts of science to mankind. Science has freed men's minds. Foremost among liberating ideas is the belief that there is order and law in the universe and that this order can be discovered by questioning Nature herself. Such belief was rare in the Middle Ages when processes of Nature were generally attributed to supernatural causes: winds and storms to demons, comets and epidemics to the wrath of the Almighty towards a sinful world, and investigations of Nature were persecuted by both Church and State as Satanic magic and sacrilegious questioning of the acts of God. The Copernican theory widened our physical horizons and showed our earth as a tiny speck in a universe of worlds. The theory of evolution brought a unity to our ideas of the organic world. The discovery of the mechanism of inheritance allowed an evaluation of the contributions of heredity and environment to the personality of individuals. The experimental method with adequate controls is the most valuable tool science has yet developed. Its understanding and use in daily life would mean more than all the scientific facts that schools can teach.

Science has helped to free man's soul. It has broadened the horizons of religion and given it a new point of view away from the old intolerant, materialistic theology when men sought their own salvation from selfish hope of heaven or fear of hell and persecuted or even killed those who did not conform to the authority of orthodox beliefs. Elimination of such incumbrances has left to religion a freer field for the cultivation of its great spiritual values.

Science has banished much of ignorance and superstition, but much remains. Recently in New York's Pennsylvania Station I purchased seven different magazines on astrology. One of them, and this not the best seller according to my newsdealer, I found had a monthly paid circulation of more than 132,000 copies. The readers of these astrological journals are part of our democracy and help to form the policies of our Government. Other examples need not be given to show that the scientific method has not yet saturated our land.

If we consider past efforts to better mankind, it is clear that good intentions are untrustworthy criteria of service to humanity. The biblical criterion—"By their fruits ye shall know them"—is biologically sound doctrine and still the best test. The attempts to suppress independent thought and study of Nature in the Middle Ages, and up to the not distant past in our own country, were inspired by noble motives, but they put civilization back by many centuries. The Crusaders had a lofty purpose but a trivial objective: the capture of an empty tomb, with all too slight appreciation of the teachings of Him whom the tomb had held.

During the plague of the seventeenth century when twenty-five million people or a quarter of the population of Europe died of this dread disease, there were doubtless, as there should have been, hospitals and other organized efforts to minister to the sick and dying. We can imagine the scant attention that would have been then paid to a request for a grant for a scientific study of the life habits of such creatures as rats, fleas and the wriggling animalcules which Leeuwenhoek discovered at about this time in drops of putrid water. Yet our knowledge of rats, fleas and bacteria is one reason why centuries later pest hospitals are not found in London and we no longer dread the plague. The illustration given is an example of the unsuspected value of knowledge in apparently unrelated fields. Many other examples could be given of the service of science to human welfare, a service which is often indirect. The ancients used human sacrifices to ensure bountiful harvests. Now we use commercial fertilizers for this purpose and find them more efficient. In the old days people fought yellow fever and smallpox by church rites and religious processions. Now we fight these diseases by killing mosquitoes and by vaccination. Formerly thousands of people were executed on the ground that they were witches. Science has proved that witchcraft does not exist. It would be difficult to give from history as striking examples of success in direct efforts to improve the condition of mankind without the aid of science.

Knowledge is power also in our efforts towards human betterment. We must learn the facts about the environment in which we live if we wish to adjust ourself into harmony with it. Efforts against Nature are doomed to failure despite high motives. It is for this reason we believe that in a rational programme for human betterment science—the free search for truth—is in the long run the best investment. If what I have said is true, it lays upon us all, both scientist and layman, a responsibility for the advancement of science, free and unhindered as a service to mankind. Think where we would have been now if in the Dark Ages men like Copernicus, Galileo, Albertus Magnus, Roger and Francis Bacon among other inquiring minds had been able to carry on their scientific investigations in an atmosphere of intellectual freedom. Our most difficult sciences might now have reached the stage occupied by biology, for example, and we might already have found a remedy for our present sick civilization.

How can science best be fostered ? I need offer only a few suggestions.

Science, in common with all intellectual pursuits, needs tolerance, freedom from restraint and a recognition of the value of individuality. Men differ widely in their capacities for research. A great need therefore in the advancement of science, as of other intellectual endeavours, is to devise means for discovering the exceptional abilities at an early age and giving such abilities exceptional opportunities in order that their span of effective service with its social values may be prolonged.

The public, whom science serves, knows all too little what science really means. The magic and gadgetry of scientific applications rather than the methods and ideals of science make the great appeal. Yet the ideals and methods would help society reach judgments on the basis of ascertained facts rather than through emotional appeal and personal profit, and would transform our daily lives if universally applied. Think what a chance would come if our representatives in legislative halls should open each session with the prayer of Huxley: "God give me strength to face a fact though it slay me"—and really mean it.

A common comment of a layman after visiting a laboratory and having research explained to him is: "What great patience scientists must have !". The real thought appears to be how can reasonably intelligent men, as men of science seem to be, be content to spend time in such trivial and uninteresting details. The layman seems to feel as he might in watching a small child picking up little white pebbles laboriously one by one and putting them into a bucket, and then taking them out again one by one in the same painstaking manner. Yet this same layman sees reason in taking a stick and whacking a diminutive white ball over a field, alone or in company with others, and each time he gets it into a little sunken bucket he takes it out again and whacks it to another bucket of the same dimensions. Science as well as golf is a sport to those who play the game and there is a chance of some bit of human value when the game is done.

In the promotion of human welfare through the advancement of science, men of science and the public have a common interest and may have a common share. I believe the American Association is especially adapted to furthering these common interests and could profitably undertake a study looking towards the development of a more effective programme that would serve the aims of man of science and layman alike.

In the United States as nowhere else patrons of art, literature and science have made investments in human good. The yields in benefits secured have varied much, but sometimes have been slight because the investments have been unsound. We trust that those of philanthropic intent who wish to promote human welfare through the methods of science will subject their donations to as careful checks as they would a financial investment in order to ensure a profitable yield in the way of scientific dividends. A newly established National Science Fund is in position to serve as a clearing house for advice on the probable scientific dividends which may be expected from investments in science.

Although we do, each of us, live in different and more or less separate worlds of our own, I trust we shall ultimately be able to acquire a social organization as orderly as the constellations of other worlds. In our fight for individuality and freedom in this War and in the peace to come, I do not despair. The experimental method has demonstrated we must use force without stint to show that freedom and political morality as well as personal honesty really pay. We still cherish the faith that the free search for truth by the methods of science has power to rebuild the world and will prevail.

SRINIVASA RAMANUJAN*

By PROF. E. H. NEVILLE
University, Reading

SRINIVASA RAMANUJAN was a mathematician so great that his name transcends jealousies, the one superlatively great mathematician whom India has produced in the last thousand years. He was born at the village of Erode in Tanjore on December 22, 1887. His parents were Brahmins of high caste, but very poor, and without any means of direct access to influential people. Srinivasa's mathematical ability was soon recognized at the high school at the neighbouring town of Kumbakonam, which he entered at the age of seven. We are told with what delight the big sixth-form boys found at the bottom of the school a youngster who was ready to do all their hard sums for them, and with what mixed feelings he read in their books theorems which he had discovered for himself. In 1903, a few months before he left the high school with a scholarship to the Government college in the same town, there came into his hands a "Synopsis of Mathematics", a book containing the enunciations of some six thousand theorems, for the most part without proofs, and Ramanujan set to work systematically to establish the results. Geometry did not appeal to him, but in algebra and calculus he found himself in a magic world, in which he lived for the next ten years. In proving one formula he discovered many others, and he began to compile a note-book, the first of the note-books which afterwards became famous.

Unfortunately, Ramanujan lived too completely in his new world. College regulations could secure his bodily presence at a lecture on history or physiology, but his mind was free, or, shall we say, was the slave of his genius. We know now that to describe one hour which Srinivasa Ramanujan spent on mathematics as mis-spent is absurd, but to the college authorities he was just a student who was neglecting flagrantly all but one of the subjects he was supposed to be studying. The penalty was inevitable: his scholarship was taken away, and he was told that he must repeat the year's course. So he ran away, and what he did and how he lived for the next few years is not on record. He returned to college for a short time, but failed to secure any academic qualifications.

Away from college, Ramanujan's wants were few, and for five years he was able to satisfy them without interrupting his investigations. But in 1909 he married, and needed definite employment. His unfortunate college record was a serious obstacle, and he obtained introductions from one to another of three Indian mathematicians, Ramaswami Aiyar at Tirukoilur, Seshu Aiyar in Madras, and Ramachandra Rao at Nellore, to whom in turn he produced his note-books as evidence that he was not the incorrigible idler his failures seemed to imply. Ramachandra Rao has given an account of Ramanujan's first interviews with him:

"Several years ago, a nephew of mine, perfectly innocent of mathematical knowledge, spoke to me: 'Uncle, I have a visitor who talks of mathematics. I do not understand him. Can you see if there is anything in his talk?' And in the plenitude of my mathematical wisdom, I condescended to permit Ramanujan to walk into my presence. A short, uncouth figure, stout, unshaved, not over-clean, with one conspicuous feature—shining eyes—walked in, with a frayed note-book under his arm. He was miserably poor. He had run away from Kumbakonam to get leisure in Madras to pursue his studies. He never craved for any distinction. He wanted leisure; in other words, simple food to be provided for him without exertion on his part, and that he should be allowed to dream on.

"He opened his note-book, and began to explain some of his discoveries. I saw quite at once that there was something out of the way, but my knowledge did not permit me to judge whether he talked sense or nonsense. Suspending judgment, I asked him to come over again, and he did. And then he had gauged my ignorance, and showed me some of his simpler results. I asked him what he wanted. He said he just wanted a pittance to live on so that he might pursue his researches. It is a matter of considerable pride to me that I was in some way useful to this remarkable genius in his earlier days."

Ramachandra Rao's interest took the most practical and generous form. He sent Ramanujan back to Madras so that he might work at the University there, and for a little more than a year he maintained him at his own expense. Many people, in India and in England, have been proud that they helped Ramanujan; of them all, perhaps his first benefactor deserves the highest praise.

* A talk broadcast in Hindustani in the Indian service on April 22, 1941.

Ramanujan, unwilling to be a burden for life, took in 1912 a clerkship under the Madras Port Trust, but Ramachandra Rao soon let the authorities of the Trust know what sort of a clerk they were employing, and thenceforward every assistance was given to Ramanujan. Francis Spring, the chairman of the Trust, made his post into a sinecure, and resolved to take the first opportunity of discussing the case with someone competent to appreciate Ramanujan's work. The opportunity came less than a year later, when an official visit was paid to Madras by Gilbert Walker, then director-general of observatories in India, a first-class mathematician trained in Cambridge. Walker's verdict, though he did not see Ramanujan and had only specimens of his work and not the note-books themselves to inspect, was unhesitating, and he wrote to the University authorities in Madras in the most emphatic terms: "The University would be justified in enabling S. Ramanujan for a few years at least to spend the whole of his time on mathematics, without any anxiety as to his livelihood." The words "at least" in this sentence are very remarkable. The University responded willingly, and with as little delay as was compatible with the fact that the situation was so far outside all precedent that explicit permission had to be secured from the Government of the Presidency, and on May 1, 1913, Srinivasa Ramanujan entered the Presidency College in Madras to practise as a virtue that single-minded devotion to mathematics which had been a vice in Kumbakonam nine years earlier.

Meanwhile, Ramanujan's name had become well known in Cambridge, the home of mathematics in England. G. H. Hardy, then a young lecturer at Trinity College and now the dominant figure among English mathematicians, who was destined to be closely associated with Ramanujan in the future, has sometimes said that Ramanujan was his discovery, but the truth is that Ramanujan chose Hardy. In a booklet dated 1910, Ramanujan found for the first time formulæ like some of his own, and acting on the advice of Seshu Aiyar, he wrote on January 16, 1913, a letter to the unknown author. No one who was in the mathematical circles in Cambridge at that time can forget the sensation caused by this letter. An obscure Indian clerk was appealing for advice because he was inexperienced, for help in the publication of his theorems because he was poor. "But only", he said, "if you are convinced that there is anything of value." Of the theorems sent without demonstrations, by this clerk of whom we had never heard, not one could have been set in the most advanced mathematical examination in the world. It must be confessed that the first suggestion was that the letter was a hoax, that the theorems must be familiar theorems skilfully disguised, but this explanation was soon abandoned, for there were some formulæ in the letter for which it certainly could not account. Of these Hardy has said, "They defeated me completely; I had never seen anything in the least like them before. A single look at them is enough to show that they could only be written down by a mathematician of the highest class. They must be true because, if they were not true, no one would have had the imagination to invent them." A great mathematician who has discovered formulæ of an entirely novel kind does not use them to mystify his friends.

Hardy answered the letter promptly, and Ramanujan knew that at last his intellectual solitude was at an end. His friends in India encouraged him and supported him, but none of them had the knowledge to bring him the human satisfaction of being understood and appreciated; to Hardy he wrote, "I have found a friend in you who views my labours sympathetically."

But if Ramanujan was contented because he had escaped drudgery and loneliness, in Cambridge it was clear that his genius was still in danger of being wasted. It is not that any brain could do mightier work anywhere than Ramanujan's had performed at Kumbakonam in the carefree days before 1909, but that mathematics is cumulative and inevitable. If the architect of the Taj Mahal had designed a different tomb for Arjumand Banu, the most beautiful building in the world to-day would not have come into existence. But if Euclid had not discovered that the number of prime numbers is infinite, nevertheless that same theorem would have been discovered long ago by somebody else. Moreover, the world of mathematics is no richer if somebody who has not heard of the theorem discovers it to-day for himself. Of Ramanujan's work before 1913, Hardy has written that it was inevitable that a very large part of it should prove on examination to have been anticipated. "He had been carrying", he says, "an impossible handicap, a poor and solitary Hindu pitting his brains against the accumulated wisdom of Europe." It is the accumulation in Europe that we have to emphasize; Ramanujan was beginning every investigation at the point from which the European mathematicians had started 150 years before him, and not at the point which they had reached in 1913. Close contact with mathematicians of the highest class was an urgent necessity for him, but he did not yet know this, and when Hardy asked if he would go to Cambridge, Ramanujan declined, reluctant to lose caste, and deferring to opposition on the part of his parents, whose objections were religious, and of some of his friends, who saw in this invitation a mean attempt to transfer to the English University the glory that belonged to Madras.

I visited Madras myself in the opening weeks of 1914. After my first lecture Ramanujan was introduced. We sat down, and he turned the pages of a note-book. Two days later he turned the pages again, and after our third meeting he said, "Perhaps you would like to take it away with you." The astounding compliment took away my breath. The priceless volume had never before been out of his hands: no Indian could understand it, no Englishman was to be trusted with it. The truth was, of course, that the English were objects of suspicion not as individuals but as components of the governing machine; I came from outside the machine, and, for no other reason than that, I enjoyed an overwhelming advantage which was grossly unfair. Richard Littlehailes, the professor of mathematics, in particular, had done and was to do far more for Ramanujan in Madras than I did.

Ramanujan's trust having been won so completely, I raised immediately the question of Cambridge, and found to my delight and surprise that Ramanujan needed no converting and that his parents' opposition had been withdrawn: in a vivid dream his mother had seen him surrounded by Europeans and heard the goddess Namagiri commanding her to stand no longer between her son and the fulfilment of his life's purpose. Lest he should be harassed presently by attempts to dissuade him, I addressed myself to the task of convincing his friends that the proposal was in Ramanujan's own interest. I wrote at once to

Hardy that the intangible obstacles had disappeared and that he must see that financial provision was made; I should try to obtain grants in Madras, but if I failed the money must somehow be found in England. I do not know what account I gave of Ramanujan and the note-books, but I made it abundantly clear that if Ramanujan was willing to come, financial difficulties simply must not be allowed to interfere. For a moment Hardy faltered. "Be careful what you promise", he wrote, and he forwarded a cautious memorandum of the "We-have-heard-of-these-untaught-geniuses-before" type, from the India Office in London. I claim no credit for ignoring this warning and laughing at Hardy's endorsement of it; I had seen the note-books and talked with Ramanujan, and Hardy had not. Moreover, while letters were travelling between Madras and London it was becoming likely that all the money wanted would be found in India. Littlehailes introduced me to everyone who carried weight in the University or in the civil administration; everywhere I talked of Ramanujan, explained as I have tried to do now the importance to him of a stay in Cambridge, and urged generosity. On January 28 I addressed to the University authorities a prophetic memorandum which began: "The discovery of the genius of S. Ramanujan of Madras promises to be the most interesting event of our time in the mathematical world", and ended: "I see no reason to doubt that his name will become one of the greatest in the history of mathematics, and the university and city of Madras will be proud to have assisted in his passage from obscurity to fame." Littlehailes drafted proposals in detail, and within a week the University, with the approval of the Government, had created a scholarship ample to maintain Ramanujan in Cambridge and his wife and mother in Kumbakonam. A few days later I left Madras.

It was in April 1914 that Ramanujan arrived in Cambridge, where he lived in my house until residential accommodation became available for him in July in Trinity. He felt the petty miseries of life in a strange civilization, the vegetables that were unpalatable because they were unfamiliar, the shoes that tormented feet that had been unconfined for twenty-six years, but he was a happy man, revelling in the mathematical society which he was entering, and idolized by the Indian students. The outbreak of war in the summer of that year affected profoundly his development. Most of the mathematicians whom it had been hoped that he would soon know disappeared from the University on war service of one kind or another; only Hardy remained, but Hardy had an unexpected amount of time at Ramanujan's disposal, and the two were constantly together. "I had to try to teach him", says Hardy, "and in a measure I succeeded, though obviously I learnt from him much more than he learnt from me." If Ramanujan's published papers are far narrower in scope than the note-books, if many of the ideas which had been born in India were neglected in England, it is because Hardy could guide Ramanujan rapidly and accompany him profitably only in regions of mathematics where he was himself at home. It was the War which separated Ramanujan from mathematicians with interests different from Hardy's but not alien to his own, and threw him into an association with Hardy so intimate that the two strands of their joint work cannot always be distinguished.

For three years, alone and in collaboration with Hardy, Ramanujan produced mathematical papers of the highest quality in rapid succession. Then he fell a victim to tuberculosis. Immediate return to India was impossible, for the war-time voyage was risky and uncomfortable. After a year's constant attention in English nursing-homes, his health showed some improvement, and he enjoyed a brief period of brilliant invention. It was at this time that the two highest academic honours in England, which had never previously been conferred on an Indian, were conferred on Ramanujan. Early in 1919 he returned to Madras: travel was again easy, and the purpose of his sojourn in Cambridge had been accomplished, his family and his friends were waiting for him, his native land was impatient to do him honour. To everyone's dismay, the voyage or the return to a warm climate caused a relapse; for a year every care was lavished on him, but he died in Madras on April 26, 1920.

During his last year he worked slowly and in pain, but the work showed the old invincible originality. His last letter to Hardy, dated January 12, 1920, is singularly reminiscent of the fateful first letter, for it, too, contained a multitude of formulæ with only the obscurest hints of the theory from which they were derived. He was developing his last theory until he died, and it is a measure of his genius that fifteen years elapsed before this theory was understood and made public.

I must not end without making an attempt to describe the man himself. In figure he was a little below medium height, and stout until emaciated by disease; he had a big head, with long black hair brushed sideways above a high forehead; his face was square, he was clean shaven, and his complexion, never really dark, grew paler during his life in England; his ears were small, his nose broad, and always his shining eyes were the conspicuous feature that Ramachandra Rao observed in 1910. He walked stiffly, with head erect and toes out-turned; if he was not talking as he walked, his arms were held clear of the body, with hands open and palms downwards. But when he talked, whether he was walking or standing, sitting or lying down, his slender fingers were for ever alive, as eloquent as his countenance. He had a fund of stories, and such was his enjoyment in telling them that in his great days his own irrepressible laughter often swallowed the climax of his narrative. He loved a paradox, but I do not know of any that he invented; the paradoxical element in some of his own early work must have made him aware that the wildest nonsense of to-day may receive a logical interpretation to-morrow. He had serious interests outside mathematics, and was always ready to discuss politics or philosophy. Loss of caste was a price he was prepared to pay for coming to England, but he kept the price as low as he could by adhering as closely as circumstances permitted to the observances of his religion, and in particular by maintaining the strictest vegetarianism. "When I go back", he said to me once, "I shall never be asked to a funeral", and if he spoke with a sigh there was no sense of pollution mingled with his regret. In everyday life he had an instinctive perfection of manners that made him a delightful guest or companion. Success and fame left his natural simplicity quite untouched. To his friends he was devoted beyond measure, and he devised curiously personal ways of showing his gratitude and expressing his affection. The wonderful mathematician was indeed a lovable man.

Had Ramanujan not left India he might be alive

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DOMESTIC ENTOMOLOGY IN WAR-TIME

By DR. J. R. BUSVINE
London School of Hygiene and Tropical Medicine

IT is a curious paradox that the cyclopean evil and stupidity of a world war stimulate intelligent co-operation within smaller spheres. Anyone who has read the pages of NATURE during the present War will be aware that men of science are giving serious thought to their organization, status and general relations with society. Progress has certainly been made in the allocation of research problems, collaboration between individuals and application of results. Unfortunately, much of what has been done lies under a war-time ban of secrecy, but anyone who knows something of the work of the Biological War Committee (see NATURE of February 28, pp. 227 and 234) is aware that this is so. It must, however, be admitted that the symposium on "Domestic Entomology" held by the Association of Applied Biologists on February 20 revealed a lack of coordination of this particular type of problem. The pest species discussed were not linked on anatomical, physiological or even ecological grounds but rather from considerations of the organization of advice and control. Domestic pest problems are constantly confronting sanitary inspectors and medical officers who usually pass them on to one research institute or another. It would seem desirable that the Ministry of Health should retain an entomologist to deal with such specialized problems.

Interest in some domestic pests waxes and wanes with external events. Thus, research on lice and scabies is stimulated by war and to some extent lapses in peace-time. The drive on slum clearance a few years ago attracted attention to that perpetuator of slum life, the bed-bug. In addition to *ad hoc* research, a long-range ecological study of the bug was initiated, the results of which are only recently available[1].

A sound film on "Malaria", produced by the Shell Oil Co., was shown. This film was designed to be shown to non-technical people to give a clear picture of the causes and control of the disease without being dull or too complex. It not only succeeded brilliantly in this but also included pictures of great interest to the professional entomologist (particularly those of the female mosquito laying eggs and the realistic animated diagrams).

Dr. Busvine described some recent applied research which seems to provide a safeguard against epidemics of lice and the terrible diseases associated with them. While people are all able to get regular changes of undergarments, the body louse is not likely to spread rapidly, and occasional cases of infestation can be dealt with by improvements on methods used in the War of 1914–18. At any time, however, unhygienic conditions may arise as a result of severe bombing, invasion or other hazards of 'total' war which may favour the louse. If this pest becomes widespread it is exceedingly hard to eradicate, as was found in Flanders in the War of 1914–18 and in other subsequent epidemics. The difficulty, which consists in rapid reinfestation of deloused persons, can now be overcome by the use of lasting insecticides, applied in various ways, which 'proof' a person for a month after treatment. These methods, which have been thoroughly tested on verminous men, were illustrated by a short amateur film.

Dr. Busvine concluded by pointing out that the head louse, which is very much more common, is very closely allied to the body louse and may possibly be a disease vector. Similar lasting insecticides would be of value for this pest, applied as 'medicated' hair dressings.

The incidence of scabies in Great Britain is on the increase—a fact that cannot entirely be ascribed to war conditions because the increase started several years ago. Dr. K. Mellanby gave an account of some interesting recent research on the transmission of scabies. The experiments were made with the amicable collaboration of pacifist volunteers and scabetic soldiers.

Some controversy has arisen over the usual mode of transmission of the parasite ; some holding that it is very largely indirect, others using that provoking word 'venereal'. It would be exceedingly difficult to discover what actually is the main mode of transmission, but Dr. Mellanby's experiments have certainly shown that indirect transmission is very much less efficient than even moderately intimate contact. Attempts to transmit the parasite on blankets or clothes were only successful one or two percentage of two or three hundred trials, whereas the mite was readily transferred between two men sleeping in the same bed, both wearing pyjamas.

Major Johnson reviewed the scabies problem from the statistical point of view. Although it is not possible to find all stages of the mite, the oviparous females can be counted with accuracy. Examination of scabetic cases revealed a remarkably low population compared with the numbers theoretically possible (estimating from the reproductive rate and length of the life cycle). Less than five live females were found on 50 per cent of the cases and only 5 per cent had more than sixty. Populations on individuals seldom rise sharply and sometimes decline to zero.

When we are living in the country we are often troubled by various families of biting flies. Dr. Kearns proposed thiocyanates as deterrents for our protection but warned us that what was effective for midges (Ceratopogoninæ) might be quite inefficient for 'clegs' (Tabanidæ). Some country houses are subject to periodic invasion by swarms of muscids and chloropids seeking to hibernate. They are very enterprising and persistent and it seems to be impossible to keep them out. The only remedy seems to be regular spraying by pyrethrum or thiocyanates in paraffin at the right time of year.

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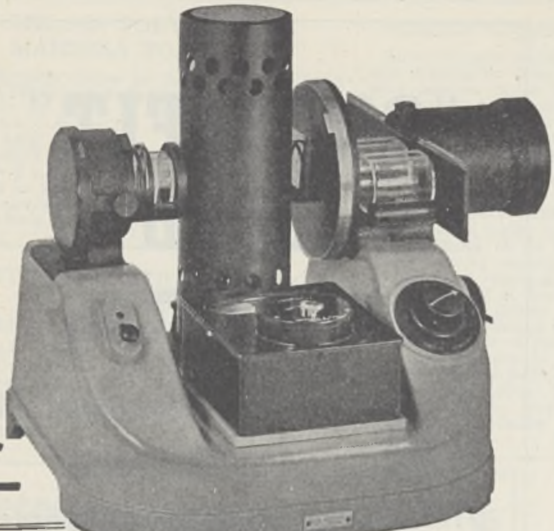

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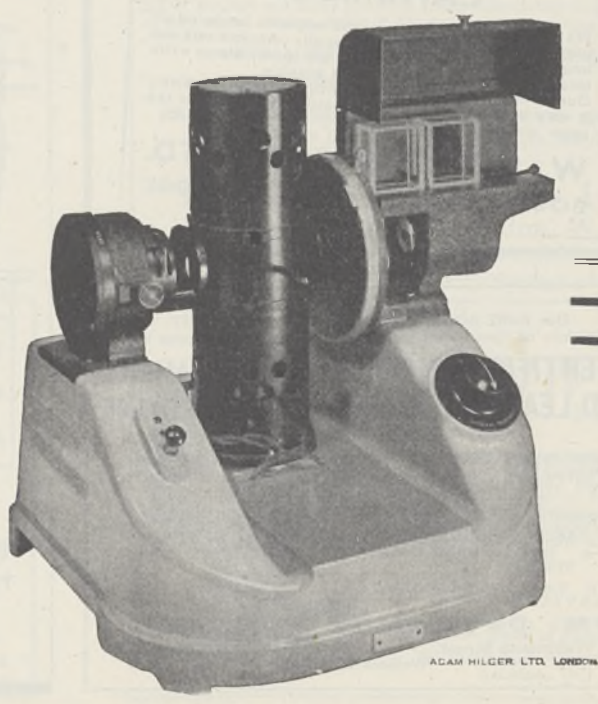

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Research Laboratory, furniture beetles are more prevalent than is often believed. Dr. Fisher pointed out that war-time furniture storage is likely to spread the trouble even further. Control of insects in wood is exceedingly difficult, but prevention of attack is much more feasible as a result of the researches on the physiology and dietetics of the pests. For example, it has been found that the so-called 'dry' wood-borer, Anobium, really needs a fairly high moisture content to flourish. Also the attack of Lyctus beetles can be prevented by elimination of starch.

Mr. Fox Wilson dealt with two pests less harmful but of considerable importance as nuisances. It is not generally realized that the invasion of houses by earwigs may actually render them uninhabitable. The reasons for such invading swarms are obscure, but they often occur on new building sites, and various connecting factors have been suggested.

The ants which trouble us in our houses and institutions may either be tropical species which have become 'domesticated' or invaders from the garden.

Both ants and earwigs can best be controlled by baiting, but whereas an arsenic-syrup bait is most effective against ants, the earwigs are most attracted by a bran-fluosilicate-fish-oil mixture.

[1] Johnson, C. G., *J. Hygiene*, 61, 345 (1942).

OBITUARIES

Prof. Hans Spemann

THE death of Hans Spemann, of Freiburg-im-Breisgau, at the end of 1941, brings to a close a lifetime of work which threw a new and most revealing light on the great problem of the development of biological form.

Spemann was born in 1869. After leaving school he spent a few years in his father's business and in the performance of his military service, before beginning the study of medicine at the Universities of Heidelberg, Munich and Würzburg. He held his first position as a lecturer at the last-named University, passing from there to become professor of zoology at Rostock in 1908. During the War of 1914–18 he held a chair at the Kaiser Wilhelm Institute in Berlin, and in 1919 he was called to the professorship at Freiburg-im-Breisgau, which he held until his retirement in 1935, the year in which he was awarded a Nobel Prize for medicine.

Spemann's work did not cover a wide range of topics. His second paper, published in 1898, dealt with the development of the Amphibia ; and this remained his field of investigation throughout his whole life. His great achievement was to bring into fruitful co-ordination the two, in themselves inconclusive, lines of attack which had been opened up in the casual investigation of development. On one hand, the studies of Roux and Driesch on the developmental potentialities of the first-formed blastomeres of the egg, although they tackled the major problems of the formation of the animal as a whole, seemed to lead only to a sterile paradox. On the other hand, Roux's notion of dependent differentiation appeared to suggest a plausible causal mechanism for development, but the one known example of it, and that a somewhat doubtful one, was concerned with the development of a single organ, the lens of the eye. Spemann entered both these fields, with his famous constriction experiments on the early cleavage stages of Triton, and his early grafting experiments on the optic rudiments of the same form. By 1918 he was able to bring forward his concept of the 'organization-centre', and demonstrate that the morphogenesis of the embryo, in its main outlines as well as in its details, is the result of interactions between different regions of tissue. For the next fourteen years, Spemann was the leader of a school, which rapidly filled in the outlines of what had come to be called 'embryonic induction' ; their work was summarized in his Croonian Lecture of 1927. In 1932 he participated in the next major step forward, the beginning of the physico-chemical investigation of the process.

Although his work was one of the most important influences in the final discredit of vitalism, Spemann was never one of those who hoped that the discovery of the organizer would rapidly enable us to reduce the problem of biological form to a few simple chemical statements. His attitude was, in fact, much more a biological than a physico-chemical one. The extreme caution with which he formed his conclusions, joined with intense concentration on a narrow field favourable for an attack on fundamental problems, enabled him to lay a foundation on which the science of experimental morphogenesis can be securely based. C. H. WADDINGTON.

The Right Hon. Lord Salvesen, P.C., K.C.

EDWARD THEODORE SALVESEN brought to his profession and to his hobbies the vigour and enthusiasm bequeathed him by his Norwegian forebears. His profession carried him, by way of the University of Edinburgh, the Scots Bar and a sheriffdom, to a judgeship in the Court of Session of Scotland. His hobbies and his public interests were too many to mention, but he accomplished much for the veterans of the War of 1914–18 (in which his three sons were killed), he helped to reform the divorce law of Scotland, and he was a strong advocate of public-house reform. But his lasting memorial is the Scottish Zoological Park.

It was largely owing to his advocacy and to his energetic leadership as president of the Zoological Society of Scotland, founded in 1909 for the establishment of a national zoological park, the advancement of zoology, and the study of the native animals of Scotland, that the Park was opened in 1913. At that time it was a new venture in British zoos. The site of seventy-four acres with its mansion-house, gardens, fine trees and abundant natural exposures of rock invited broad and picturesque treatment, and the late Sir Patrick Geddes and Mr. F. C. Mears prepared the scheme for laying out the grounds.

Developments, carried out step by step under Lord Salvesen's guidance, as the funds of the Society warranted, have resulted in a park of great attraction, with spacious paddocks, and rocky dens in which the animals live and are seen to the best advantage.

Lord Salvesen presented to the Society its acclimatization house adapted for some less hardy creatures, and was instrumental in obtaining from the Carnegie Trustees the grant which built the Carnegie Aquarium. His and his brother's connexion with the whaling industry in South Georgia enabled them to bring together in the Park what must have been a unique collection of penguins in captivity. For at its best the collection comprised twenty-eight king penguins, which regularly bred and reared young, in addition to the ringed, gentu, rock-hopper and black-footed species. The War, alas, has destroyed some of the glory of that interesting group, as it has interfered with many of the accustomed inhabitants of the Park; but Lord Salvesen's experiment in planning a modern zoological garden has been abundantly justified and will continue for long to give to its many visitors pleasure mingled with instruction.

After a short period of ill-health Lord Salvesen died on February 23, still a man of vigour, in his eighty-fifth year.

JAMES RITCHIE.

WE regret to announce the following deaths:

Sir Henry Brackenbury, vice-president of the British Medical Association and, during 1927–34, chairman of the Council, on March 8.

Dr. H. D. Curtis, head of the Department of Astronomy and director of the Observatory, University of Michigan, on January 8, aged sixty-nine.

Prof. H. W. Foote, professor of physical chemistry in Yale University, on January 14, aged sixty-six.

Mr. P. G. Redington, forest supervisor of the U.S. Forest Service, formerly chief of the U.S. Biological Survey, on January 12, aged sixty-three.

Mr. F. J. Selby, C.B.E., secretary of the National Physical Laboratory during 1918–32, on March 5, aged seventy-four.

NEWS and VIEWS

The Poulkovo Observatory

INFORMATION that the Poulkovo Observatory had been severely damaged in the German bombardment of Leningrad was first received in a special message to the men of science of Great Britain broadcast from the besieged city on October 8, 1941, by Prof. Vassily Ogorodnikov, professor of physics in the University of Leningrad, who was fighting in the ranks of the Red Army defending Leningrad. The Observatory lies some twelve miles south of Leningrad, not far from the railway line from the German frontier to that city. The shelling of the Observatory appears to have been deliberate, and from later information it is learnt that its destruction is practically complete.

The Poulkovo Observatory was founded in 1839 by the Emperor Nicholas and recently celebrated its centenary. The first director was F. G. W. Struve (1793–1864), who had been the director of the Dorpat Observatory during 1818–1839. He was commanded by the Emperor to design and erect, almost regardless of cost, the most perfect and complete observatory that he could devise. Struve had a zeal for refined and precise methods of observation and, in addition, an inventive mechanical and engineering capacity, and he took full advantage of this unique opportunity. His "Description de l'Observatoire Astronomique Central de Pulkowa" is a work which, in the words of Sir David Gill, "no one, even in the present day, who may be charged with the design and erection of a great observatory, can afford to neglect". From the time of its foundation, the Poulkovo Observatory has taken a leading part in fundamental astronomy, for which its high latitude particularly fitted it. The standard refraction tables used in the reduction of astronomical observations are the Poulkovo refractions, based on Poulkovo observations. The fundamental observations made there have always been planned with care and characterized by their high accuracy, so that in the formation of a fundamental system of star places the Poulkovo catalogues receive very high weight.

The instrumental equipment of the Observatory included a Repsold meridian circle, an Ertel-Merz vertical circle, a Repsold prime-meridian transit instrument, a Repsold-Clark 30-in. refractor of 46 ft. focus, a Repsold-Merz 15-in. refractor of 27 ft. focus, in addition to numerous smaller instruments. F. G. W. Struve retired in 1861 and was succeeded as director by his son, O. W. Struve (1819–1905), who retired in 1889. The two Struves between them practically laid the foundations of double-star astronomy, by their discoveries and observations of double stars. J. O. Backlund (1846–1916), who was director during 1895–1916, made important investigations on Encke's Comet, the period of which (about 3·3 years) shortened by 2½ days between 1819 and 1914. In a memoir that is a classic, he showed that the motion of the comet is retarded in a narrow region not far from perihelion by a resistance of some sort, and that this resistance has decreased rather abruptly several times. The library of the Poulkovo Observatory was one of the most complete astronomical libraries in existence, and its treasures included many of the manuscripts of Kepler. It is hoped that steps had been taken before the German attack to remove the valuable books and manuscripts to a place of safety. The Poulkovo Observatory was an institution of which the Russians were justly proud, and men of science in all countries will share with them their grief at its destruction.

Scientific Co-operation between Great Britain and the U.S.S.R.

THE Parliamentary Secretary of the Ministry of Information (Mr. Ernest Thurtle, M.P.) opened a conference of British scientific and technical institutes on March 9 at which Sir John Russell, adviser to the Soviet Relations Branch of the Ministry of Information, took the chair. The conference, which took place in the rooms of the Royal Society, was called to discuss an intensification of the exchange of technical and scientific information between the U.S.S.R. and Great Britain. Some sixty scientific organizations and learned societies of Great Britain sent representatives to the conference, and it was decided to set up a standing committee to assist the Ministry of Information in this work and to act as a clearing-house between organizations in Great Britain and their opposite numbers in the U.S.S.R. A representative of the Soviet Government is to be invited to join the sub-committee.

Government Plans for Reconstruction

WITH the completion of the recent Cabinet changes, it is announced that Sir William Jowitt, who was Solicitor-General, has been appointed Paymaster-General, in succession to Lord Hankey. The duties hitherto performed by the Minister without Portfolio in connexion with the study of post-war reconstruction problems will in future be carried out by the Paymaster-General, who has been charged with general responsibility for organizing and co-ordinating the work on reconstruction problems now being carried out by the various Departments of State. For this purpose he will have at his disposal the special section which has been engaged on this work under the Minister without Portfolio. Arrangements will continue whereby reconstruction questions are considered by a committee of Ministers containing representatives of the political parties. Mr. H. G. Strauss, M.P., has been appointed an additional Parliamentary Secretary at the Ministry of Works and Buildings. In this office, Mr. Strauss will be responsible under the Minister for the planning functions of the Ministry.

The general responsibility hitherto entrusted to the Minister without Portfolio in regard to export surpluses and allied post-war relief will in future be exercised by the President of the Board of Trade. It is also officially announced that Sir Frederick Leith-Ross, chief economic adviser to the Government, will continue to direct the organization concerned with export surpluses and allied post-war relief, which will now be attached to the Board of Trade instead of to the Ministry of Economic Warfare, and he will relinquish his post as Director-General of the Ministry of Economic Warfare.

Scientific Invention at the Service of the Community

MR. P. H. B. LYON, headmaster of Rugby School, was in the chair when Capt. John Langdon-Davies addressed the Rugby branch of the Association of Scientific Workers on March 5 on "Scientific Invention at the Service of the Community". After referring to Prof. J. D. Bernal's book on "The Social Function of Science" as giving a detailed picture of the organization of science and the imperfections consequent upon a system of production for profit, Capt. Langdon-Davies passed on to a consideration of the effects of social phenomena that influence education more than do schools and universities, such as advertising, with its creation of false appetites for 'streamlined' refrigerators. The need is for social planning, including a planned attack by men of science on the most urgent problems, not only of war but also of peace. Capt. Langdon-Davies looks to the development of substitutes for raw materials such as rubber, as a means of wiping out the pools of semi-slave cheap native labour which he regards as one of the prime causes of imperialistic conflict. Only by raising the standards of life of the peoples of Asia and Africa, he contended, can we hope for permanent social security. He pointed out that science exercises an influence on spiritual values, suggesting that the moral theology of the medieval Schoolmen was not unscientific but based on the incorrect science of Aristotelean physiology. He called for a "sense of reverence" from scientific workers. In conclusion, he insisted that scientific method must be applied to politics and economics, demanding, however, that we must preserve our criteria and standards of scientific truth in politics.

Centenary of General Shrapnell

ON March 13, 1842, Lieut.-General Henry Shrapnell, the distinguished artillerist and inventor, died at his home, Peartree House, Southampton, at the age of eighty, having spent his whole career in the improvement of guns and projectiles. Born at Bradford-on-Avon on June 3, 1761, he entered the Royal Artillery at the age of eighteen and continued to serve until 1825, when he was retired with the rank of major-general. In 1837 he was promoted lieutenant-general. Fused hollow shells had been used since the time of Vauban, but Shrapnell was the first to introduce shells filled with musket bullets and with a bursting charge for firing from long guns. His first demonstration was made at Gibraltar in 1788, but it was not until 1803 that Shrapnell shells were adopted by the Board of Ordnance. In that year Shrapnell carried out a large number of firing experiments at the works of the Carron Company, Falkirk, and the company was given orders for large numbers of this new projectile. Shrapnell shells were used at the Siege of Surinam in 1803, in the Peninsular War and at the Battle of Waterloo. The inventor spent many thousands of pounds of his own money on the experiments; he was given a pension of £1,200 in 1814. At his death Shrapnell was buried in the family vault in the parish church of Bradford-on-Avon, where a tablet erroneously gives the year of his death as 1847.

Uses of Colloidal Graphite Solutions

THE general scarcity of metals lends a special interest to the use of dispersions of colloidal graphite in water for making non-metallic bodies electrically conducting. On glass or similar substances which can be thoroughly cleaned with chromic acid, the graphite dispersion can be applied with a soft brush. Glass elbows and intricately shaped parts of evacuated systems can, by this method, be fitted with conducting shielding. Absorbent surfaces such as wood veneer or rubber tubing are best saturated to a slight depth below the surface with a dilute solution and then coated with the more concentrated form. It is suggested that by this means cabinets or even whole research rooms can be electrically shielded by applying the liquid by brush-painting or air-spraying followed by air-drying. Soft-cloth polishing, by forcing the particles into closer contact, automatically increases electrical conductivity. Leads for connexions or for earthing the screens are sealed into the glass or are fitted externally before applying the liquid. In Great Britain the product is sold as 'Aquadag' by Messrs. E. G. Acheson, of 9 Gayfere Street, London, S.W.1. Details were published in 1936 by B. H. Porter in NATURE, 137, 1034, and in the *Review of Scientific Instruments*, 7, 101.

The Hannah Dairy Research Institute

THE activities of the Hannah Dairy Research Institute, Kirkhill, Ayr, described in its twelfth annual report, are, as would be expected, chiefly concerned with the maintenance of the country's milk supply. The problem is approached from two main aspects, namely, the biological and the technical. Under the former category come investigations as to the provision of adequate home-grown feeding-stuffs and the avoidance of disease in the herd. Grass silage has been successfully produced in large quantities on the Institute's farm; but dried grass, though a first-class product from the feeding point of view, is regarded as probably not economic for the moderate-sized dairy farm. The possibility of improving the protein ration by feeding non-protein nitrogen compounds such as urea, with the idea that it would be converted into protein in the rumen of the animal, is under investigation. No far-reaching results are yet announced, but when roughly one third of the protein of the production ration was supplied in this form, the health, milk yields and body weights of the cows remained unimpaired during the six-week trial period. As regards disease prevention, control measures against mastitis have been extended, and the use of sulphanilamide administered orally has met with marked success. Dried milk products are being studied on the technical side, factors affecting their solubility and keeping quality receiving special attention. It appears that the addition of antioxidants to the precondensed milk before drying considerably increases the keeping quality of the resultant powder.

Earthquake at Santa Barbara, California

FROM *Earthquake Notes* of December, 1941, we learn that a severe earthquake occurred at Santa Barbara, California, at 11.51 p.m. P.S.T. on June 30, 1941. This was followed by a swarm of after-shocks which continued for several days. Shocks of any consequence ceased to occur at about noon on July 3, but three shocks were reported on this date. A preliminary report from the seismological laboratory at Pasadena gives the epicentre location as 34° 20′ N., 119° 35′ W. This position is about eight miles off shore in a south-easterly direction from Santa Barbara. Damage was estimated at about 150,000 dollars. Maximum intensity was about VII or VIII on the modified Mercalli scale. Accelerograph records of this shock were obtained at Santa Barbara, Long Beach and Vernon. The record obtained at Santa Barbara is being analysed by integration methods and the results are expected later.

"Davitamon-Five" Vitamin Tablets

MESSRS. ORGANON LABORATORIES, LTD., Brettenham House, Lancaster Place, London, W.C.2, have recently put on the market a new preparation of vitamin tablets named "Davitamon-Five". This preparation is intended for those people who wish to ensure that they are ingesting an adequate quantity of essential vitamins. The tablets are intended for the day-to-day prophylaxis and treatment of mild hypovitaminoses; and since a number of research workers have made it clear that specific avitaminotic symptoms are abolished more rapidly when the diet is adequate in the other vitamins, they can also be used to provide a suitable background for an intensive single-vitamin therapy. Each tablet contains: 1,000 I.U. vitamin A; 50 I.U. vitamin B_1; 200 I.U. vitamin C; 200 I.U. vitamin D; 0·5 mgm. *PP* factor of the B complex. A sample of the tablets can be obtained from the above laboratories.

Science Masters' Association: Annual Meeting

THE forty-first annual meeting of the Science Masters' Association will be held at Rugby School during April 8–10, under the presidency of Mr. P. H. B. Lyon, headmaster of Rugby School. The subject of the presidential address will be "English in the Science Course". Lectures will be delivered by Prof. M. L. E. Oliphant on "Recent Practical Applications of Nuclear Physics" and by Mr. L. J. F. Brimble on "Human Biology in Education". Prof. L. T. Hogben will deliver the Science and Citizenship Lecture. A discussion on "Science in Post-war Education" will be opened by Mr. E. G. Savage. Further information can be obtained from Mr. W. Askhurst, Grammar School, Stretford, Lancs.

Announcements

PROF. A. W. M. ELLIS, professor of medicine, University of London, has been appointed director of research in industrial medicine by the Medical Research Council.

SIR EDWARD APPLETON, secretary of the Department of Scientific and Industrial Research, will deliver the twenty-sixth Guthrie Lecture of the Physical Society on March 20. He will speak on "Ionospheric Influences on Geomagnetism".

MR. W. T. HALCROW will deliver the thirty-second May Lecture of the Institute of Metals on May 31 at the Institution of Mechanical Engineers. The title of the Lecture will be "Water Power and its Application to the Production of Metals".

MR. S. BAIRSTOW, of the Chemical Research Section, Research Department, of the London Midland and Scottish Railway, has been awarded the Herbert Jackson Prize for 1941, for a paper entitled "The Relation between Calorific Value and the Road Performance of Producer-Gas Vehicles".

AT the request of the Minister of Agriculture, the National Institute of Agricultural Botany has set up a special Seed Production Committee the duty of which will be to take all possible steps to stimulate, co-ordinate and ensure home seed production. The chairman of the Committee is Mr. W. Gavin, agricultural adviser to the Ministry of Agriculture. The executive officer is Mr. Leslie E. Cook, and all communications should be addressed to him at the National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

A COPY of the third (revised) edition of a pamphlet on "The Colorimetric Determination of Oxidation-Reduction Balance" has been received from the British Drug Houses, Ltd., Graham Street, London, N.1. This gives in simple language a summary of the theory of oxidation-reduction processes and potentials, and of oxidation-reduction indicators and their uses in volumetric analysis and in several fields of work, including biochemistry and soil chemistry. Copies of this useful pamphlet can be obtained free of charge on application to the British Drug Houses, Ltd.

THE Lady Tata Memorial Trust is prepared to consider applications from workers in Great Britain for grants or scholarships for the year beginning October 1, 1942, for research on blood diseases, with special reference to leukæmia. Under present conditions it is not possible to deal with new applications from workers overseas. Inquiries must be addressed to the Secretary, Scientific Advisory Committee, Lady Tata Memorial Trust, c/o London School of Hygiene, Keppel Street, London, W.C.1, not later than March 31.

LETTERS TO THE EDITORS

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

Excretion of Ketosteroids in Human Pregnancy Urine in Relation to the Sex of the Fœtus

IT has long been known that when a cow gives birth to calves, one a male and the other a female, the male will grow into a normal bull while the female may be a freemartin. The freemartin is zygotically a female and the external genitalia and mammary glands, though modified, are usually of female type, but the gonads histologically resemble testes rather than ovaries and there is a tendency for the Wolffian ducts to persist whereas the oviducts are absent or incomplete. Fusion of the placentæ with anastomosis of their blood vessels is an essential factor in producing the freemartin. Because of the common blood supply the testicular hormones of the male have free access to the female twin and cause her reproductive organs including her gonads to conform towards the male type. Parabiosis experiments in animals and also histological examination of embryonic gonads in several species seem to show that in embryos the androgenic cells of the male gonad begin to secrete before the ovary has become completely differentiated, and that the ovary does not produce secretion until a much later stage of development. It seems also that the androgens produced in early embryonic life are abundant enough to cause profound and permanent changes in the ovaries of a female twin.

These considerations suggested that it might be of interest to examine the urine of women in the early stages of gestation to discover whether the testes of a male embryo might produce enough androgen to cause a recognizable increase of androgen in the mother's urine. The most likely time for a positive result in such a test would be in early pregnancy, since involution of androgenic tissue in late pregnancy has been observed in some species.

Samples of pregnancy urine were obtained from twenty women and the ketosteroids estimated colorimetrically. Collection of complete 24-hour specimens proved impracticable and the estimations were carried out on samples of morning urine. All urines were collected 8–12 weeks after the last menstrual period. It was afterwards determined that fourteen women were bearing a male fœtus; their average ketosteroid excretion was 26·2 mgm. per litre. The six women bearing female fœtuses had an average excretion of 14·6 mgm. per litre. When account is taken of the wide range of the individual values in these two series, it is apparent that the difference between the mean excretions is not significant ($t = 1{\cdot}8$). The highest value observed in a female pregnancy was 19·8 mgm. Seven of the male pregnancy values exceeded 20 mgm., the highest value being 80 mgm. per litre. Assays carried out at later stages of the pregnancies showed that initially high ketosteroid contents tended to fall whereas moderate assays remained substantially unchanged.

Details of these experiments will be published elsewhere. We are unable to continue this work at the moment and the purpose of this note is to suggest that it would be interesting to examine a larger series. We realize fully the limitations imposed by the smallness of the present series, but the facts that (*a*) the seven very high values reported above all occurred in male pregnancies, and that (*b*) in the later stages of pregnancy these values tended to fall to the general average for all the cases, are in agreement with the hypothesis that the source of the extra excretion lies in the gonad of the fœtus. The possibility that the fœtal adrenal cortex plays some part cannot, of course, be excluded.

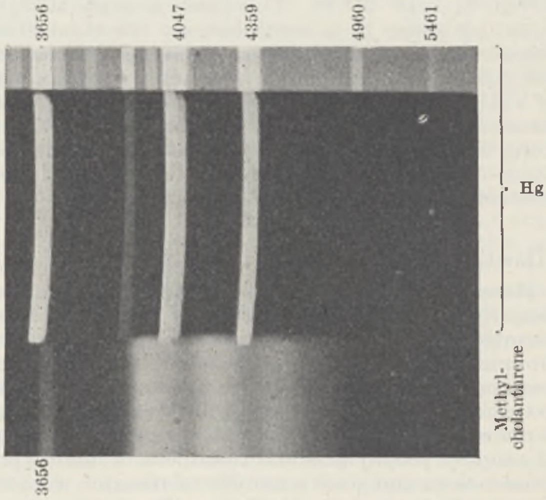
HAROLD BURROWS.
DOUGLAS H. MACLEOD.
F. LL. WARREN.

The Chester Beatty Research Institute,
The Royal Cancer Hospital (Free),
London, S.W.3.
Feb. 24.

Fluorescence of Methylcholanthrene

THE letter on "Fluorescent Lipoidal Spectra of Human Tissue" in NATURE of February 14, p. 193, requires comment upon several points.

Dr. Penn's statement that I reported . . . "that most of the carcinogenic hydrocarbons studied were highly fluorescent and they produced characteristic bands in the regions 4000, 4180 and 4400 A" . . . is, I regret to point out, incorrect. The regions of the spectrum quoted referred to the bands shown by the carcinogenic tars and tar fractions, and by the complex carcinogenic mixture prepared from tetralin by Prof. Kennaway. Further work has only emphasized



HG SPECTRUM AND FLUORESCENCE SPECTRUM OF METHYLCHOLANTHRENE.

that the various carcinogenic hydrocarbons have different fluorescence spectra and that there is sufficient correlation between their chemical structure and spectra to make identification by this means a very useful experimental aid. Thus 1 : 2 : 5 : 6-dibenzanthracene and the "1 : 2 : 7 : 8-dibenzanthracene" prepared by E. Clar certainly gave the same fluorescence spectrum, but Prof. Cook proved that the compound which Clar thought to be 1 : 2 : 7 : 8- was really 1 : 2 : 5 : 6-dibenzanthracene. When Cook did synthesize 1 : 2 : 7 : 8-dibenzanthracene, its spectrum was found to be completely different from that of the 1 : 2 : 5 : 6- isomer.

Dr. Penn finds that cancer tissue lipoids produce a far stronger fluorescence than do the lipoids of non-cancer tissue, and that the spectra are different. The number of specimens which have shown these differences is not stated. Such a result would be most agreeable, but here we have so far failed to show any differences in fluorescence between fatty extracts of cancer and non-cancer tissues. I have not used the method of extraction which Dr. Penn considers to yield a solution of "lipo-protein" in acetone. However, this subject is still under investigation.

Dr. Penn's fluorescence spectrum of methylcholanthrene suggests that he has been the victim of an unfortunate mistake. A sample made from deoxycholic acid by Prof. Cook in 1933 and a synthetic sample made in 1938 give very much the same fluorescence spectra : three massive bands extending over about 800 units of wave-length, the well-marked mercury line 4047 lying near the interval between the first and second bands (see figure). This hydrocarbon fluoresces very powerfully in the most sensitive region (violet) of the photo-sensitivity curve of an ordinary plate, and a concentration of 1 in 400,000 is quite enough to give a strong negative in the spectrograph.

I. HIEGER.

The Chester Beatty Research Institute,
The Royal Cancer Hospital (Free),
London, S.W.3.
Feb. 20.

Biotin as a Possible Growth Factor for Insects

IT has been shown for several insects, namely, Lucilia[1], Drosophila[2] and Tribolium[3], that the larva requires a growth factor which is contained in the water-insoluble fraction of yeast and is not fat-soluble. This can be easily demonstrated with *Tribolium confusum*. This beetle, which normally breeds on wholemeal flour, grows almost equally well on a diet consisting of casein, glucose, yeast, cholesterol, salts and water added to make a water content of about 15 per cent. If a water-soluble yeast extract (prepared according to Chick and Roscoe[4]) is supplied instead of yeast, growth is very much retarded (1) (see accompanying table), but normal growth is restored by adding the water-insoluble fraction of yeast (2). The same result has been obtained with the following three species of beetles which are all common pests on stored food : *Sitodrepa panicea*, *Lasioderma serricorne* and *Silvanus surinamensis*. The need for an 'insoluble' factor in yeast seems, therefore, to be of general occurrence in insects. This factor is not fat-soluble, because the adding of a chloroform-soluble extract of yeast (3) or of wheat germ oil (4) only very slightly improves diet (1).

BASAL DIET : 50 parts casein, 50 parts glucose, 1 part cholesterol, 1 part McCollum's salt mixture and 15 parts yeast extract.
20 larvæ in each test.
Temperature 25° C., relative humidity 70 per cent.

Additions to basal diet	Period in days during which first 10 pupæ were formed
(1) None	45–53
(2) Insoluble yeast	26–31
(3) Chloroform extract of yeast	40–46
(4) Wheat germ oil	40–44
(5) Three times quantity of yeast extract	34–41
(6) None, but liver extract instead of yeast extract	43–56
(7) Marmite	32–36
(8) Lecithin	40–45
(9) Vitamin-H concentrate from yeast ...	34–40
(10) Biotin-concentrate from yolk	29–34
(11) None, but starch instead of glucose ...	30–33

It is not considered to be entirely absent from yeast extract because in that case development would presumably be impossible. This view is supported by the fact that tripling the amount of yeast extract improves the diet considerably (5). A water-soluble liver extract shows about the same deficiency (6) as the corresponding yeast extract (1). The filtrate of autoclaved yeast improves diet (1) and so does marmite (7) (which is virtually an autolysed yeast extract).

These and other properties of the insoluble factor suggest a similarity to György's vitamin H which has recently been shown to be identical with biotin and been recognized as an essential food factor for the rat[5]. Kögl[6] has shown that commercial lecithin always contains traces of biotin and, in fact, diet (1) is slightly improved by the addition of lecithin (8). György[7] prepared a vitamin-H concentrate from the water-insoluble residue of liver by autoclaving and treating the resultant solution in turn with acetone and with alcohol. The same treatment applied to the insoluble fraction of yeast yielded an extract which, when added to diet (1), improved it very con-considerably (9). Kögl's[6] original isolation of biotin from yolk was started by boiling in water and removing in turn all that precipitates with acetone and alcohol. The same treatment applied to the yolk of one egg yielded a solution which when added to diet (1) improved it almost to the efficiency of diet (2) which contained the insoluble fraction of yeast (10).

These results make it very likely that the 'insoluble' factor in question is in fact biotin. The final proof must, of course, wait until a test can be performed with pure biotin in place of insoluble yeast fraction. Although biotin has recently become available in the United States, we have so far not been able to procure a sample and have to postpone this experimentum crucis until it arrives.

It is noteworthy that a 'biotin' deficiency cannot be demonstrated with Tribolium when the carbohydrate in the diet is starch instead of glucose (11). This suggests that the purest samples of starch which are available contain sufficient traces of biotin, and presumably explains why a biotin deficiency of rats has hitherto only been demonstrated as the so-called egg-white injury (that is, in a diet which contains large amounts of egg-white). It has often been stated that rats can be grown well on a diet in which the vitamins of the B-group are supplied in a water-soluble yeast extract. Such diets should be, on paper, deficient in biotin. It may be suggested that this deficiency is usually made good by traces of biotin in starch which is almost invariably the carbohydrate used in dietary experiments. In fact, it has recently been shown that diets in which starch is replaced by sucrose are apt to give inferior results[8,9].

G. FRAENKEL.
M. BLEWETT.

Imperial College of Science and Technology,
Biological Field Station,
Slough, Bucks.
Feb. 19.

[1] Hobson, R. P., *Biochem. J.*, **27**, 1899 (1933).
[2] Tatum, E. L., *Proc. Nat. Acad. Sci.*, **25**, 490 (1939) ; **27**, 193 (1941).
[3] Fröbrich, G., *Z. vergl. Physiol.*, **27**, 335 (1939).
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A Photographic Method of Estimating the Mass of the Mesotron

WE have described[1] a method of estimating the mass of secondary particles with heavy ionization tracks in photographic emulsion which are due to some component of the cosmic ray. The method is based upon the determination of the kinetic energies of these particles and of protons with the same initial velocities, which according to our assumption produce tracks with the same mean grain spacings in the emulsion.

The method used requires to be amended in two ways:

(1) In the application of Williams's formula for scattering[2], which can be written as $\bar{\theta} = A.\frac{Ze^2}{W}\sqrt{Nt}$ in a medium with atoms of one kind, Z is the nuclear charge and N the number of atoms per unit volume. For the photographic emulsion, we have to sum up for the scattering due to the different kinds of atom with different values of Z. For this purpose we used a mean value of Z defined as $\bar{Z}.N = \sum_1^n Z_k N_k$. Since the value of $\bar{\theta}$ is deduced from that of $\bar{\theta^2}$ which is defined as $\frac{2}{\pi}$ times the mean square of θ, the value of Z to be used in our formula is the root mean square of Z, namely, $\overline{Z^2}.N = \sum_1^k Z_k^2 N_k$. While $\bar{Z}$ is 6·2, $\sqrt{\overline{Z^2}}$ is 11·3. This was pointed out to us by Dr. H. J. Bhabha in a private communication, for which our thanks are due to him.

(2) The second correction refers to the way the lengths of the ionization tracks in the emulsion were grouped together in the table given in our previous communication. There was a certain arbitrariness in our method of grouping, which while giving a series of more or less concordant values of the mesotron mass, is not sufficiently randomized. In the present calculation all the tracks are grouped together for which the mean grain spacings lie within definite ranges of 6–5, 5–4, 4–3, 3–2 μ. Further, we have used three more photographic plates exposed to neutron radiation from a radium-beryllium source to obtain a more accurate calibration curve for proton tracks.

The recalculated values of the mesotron mass are given in the accompanying table, for which A has been taken to be 3·69. If the more accurate formula (40) of Williams is taken, in which a correction for the finite nuclear radius is introduced, the value of A becomes 4·14, which raises the value of μ by 12 per cent.

Mean grain spacing 10^{-4} cm.		6–5	5–4	4–3	3–2	Mean value
Value of mesotron mass μ in units of m_0	Plate A	221	160	236	(1723)	217 ± 30
	B		316	355		336 ± 19·5
	C	278	318	342	(1743)	313 ± 18·6

Plate A was kept under air, and B under 20 cm. of water at Sandakphu, and plate C at Phari Jong, Tibet, in the Post Office building under a roof thickness of 2½ ft. of mud and wood. The consistently high values of mesotron masses found with plates B and C are probably due to the presence of proton tracks in these plates, due to collision of primary neutrons with hydrogenous matter. This is further evidence of the paucity of fast primary protons in comparison to the number of similar neutrons in the cosmic ray. In all the plates for mean grain spacing 3–2 μ, the tracks are largely due to protons; in this region the proton calibration curve is not accurate.

We have also determined the mass of the mesotron from the curvatures of the pair tracks in the emulsion; the value is found to be 186·0 m_0. Owing to the shortness of range in the emulsion of most of the star-tracks, similar determinations have not been possible with such tracks.

It is to be noted that in the calculations with Williams's formula we have used individual values of θ, rather than its mean value; this is conditioned by the nature of our investigation. The values of μ so obtained will be distributed statistically about the true value; the mean value of μ obtained for the set of observations with plate A will approximate closer to the true value than any of the individual ones.

As stated in our previous communications, the importance of these results lies in the support they give to the view that multiple mesotron production in a single act by some component of the cosmic ray is possible, the principal contributor being, according to our results, the neutron. This is in accordance with the views of Heisenberg. Further interest has been directed to this process by the recent investigations carried out in the United States, which have led to an attempt by Carlson and Schein[3] to explain the totality of the cosmic ray processes taking place in the earth's atmosphere as being due to the impact of a single primary particle, the proton. According to their views, the initial step consists in the creation in one explosive act of a large number of mesotrons, in which the primary proton by interaction with a nuclear particle in the upper atmosphere loses all its energy. So far as the creation of mesotrons is concerned, protons and neutrons are about equally effective. Our results appear then as an experimental support of Carlson and Schein's assumption. The further question then arises whether the fast neutrons which are found in the earth's atmosphere are entirely of secondary origin.

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Self-incompatibility in Polyploid Forms of Brassica and Raphanus

IN a recent paper Lewis and Modlibowska[1] have suggested that in autotetraploid pears pollen of the constitution S_1S_2 is capable of functioning in $S_1S_1S_2S_2$ styles—thus a self-incompatible diploid of the constitution S_1S_2 will produce by somatic doubling a self-compatible autotetraploid $S_1S_1S_2S_2$. In colchicine experiments I have observed many times that no such change occurs in *Brassica Rapa*, *B.*

campestris and *Raphanus sativus*—in these three species the autotetraploid and the diploid branches of colchicine-produced diploid-tetraploid sectorial chimeras have always both been self-incompatible. It was also possible in these cases to show that one was dealing with normal self-incompatibility and not with some disturbance produced by the colchicine treatment, since seeds could be obtained from both the diploid and autotetraploid branches by either bud pollination or the stigma-shaving method of Sears[2]. Lewis has also found that autotetraploid branches of *Œnothera organensis* are self-incompatible like the diploid.

The above Brassica results do not in any way invalidate Lewis and Modlibowska's suggestion that in pears S_1S_2 pollen can grow down $S_1S_1S_2S_2$ styles, since the mechanism of self-incompatibility in Brassica is different from that in pears. In Brassica, as is shown by the stigma-shaving method, self-incompatibility is due to the outer layers of the stigma while in pears it is due to the slow growth of pollen-tubes inside the style.

Brassica chinensis autotetraploids behave in the same way as those of *B. campestris* except that *B. chinensis* shows cyclic compatibility[3]. In *B. oleracea* both self-compatible and self-incompatible plants occur in the diploid[4] and both types have also been found in the autotetraploids.

It would also be interesting to know whether amphidiploids from a cross between two self-incompatible diploid Brassica species would be self-compatible since the three allotetraploid species, *B. Napus*, *B. carinata* and *B. juncea*, are self-compatible. The following two results suggest that they might be self-compatible. No self-incompatible plants have been found in the Cambridge *Raphanus sativus* × *Brassica oleracea* amphidiploids although these plants have been selfed for three generations[5,6]. It is not, however, known whether the two original parents were self-incompatible, but on the other hand, Kakizaki[4] was unable to obtain *Brassica oleracea* plants which would breed true for self-compatibility. Also amphidiploids from the cross self-incompatible *B. chinensis* × self-compatible *B. carinata* are self-compatible[7].

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Search for Petroleum in Australia

MY attention has been directed by Mr. Frederick Chapman to Mr. H. B. Milner's review which appeared in NATURE of January 4, 1941, p. 13. Certain aspects of the Lakes Entrance field were obviously not available to Mr. Milner at the time. His reference to emulsified oil is now known to have no relevance—natural unemulsified oil exists throughout the glauconite (the reservoir rock); when this oil is baled or where it has risen to or near the surface, there is no emulsion. The emulsion only occurs where water has been allowed to enter the wells and when pumping is resorted to. Under those conditions, due to the churning action of the pump used, an oil-in-water emulsion occurs.

Then again, Mr. Milner, in quoting from Government reports, says the trouble with Lakes Entrance is that there is no natural pressure to cause oil to flow in the wells when the sands are penetrated. Actually (*vide* Ranney-Fairbank report on tests of Imray Well made in the presence of Dr. Raggatt, geological adviser, Commonwealth Government, and State Mines Departmental officers), the position is as follows:

"However, in the Imray Well, which was drilled only 21 feet into the glauconite, the fluid has been rising for 695 days; the rate of rise at first was 5 feet (5·4 gallons) per day, total height of the column in the hole was 1,164 feet and the top of the column stood at 110 feet from the surface. The column was still rising on July 13th this year. The fluid column consisted of 173 feet of water and 991 feet of oil (1,100 gallons by measurement in tanks). It appears, therefore, that the fluid produced was approximately 85 per cent oil. Because of the fact that the fluid rose in the well to the height attained and would undoubtedly have risen, in time, to about 100 feet above sea level, it is indicated that instead of being termed a 'low pressure' field, Lakes Entrance might more properly be called a low permeability field. From these observations it is indicated that there is a possibility that the hydrostatic head existing below the oil sand can be turned to advantage in proper operation of horizontal wells into a natural water drive, to flush the oil into the wells."

The summarized information in the Ranney-Fairbank report furnished to the Commonwealth Government is that the oil content of these sands at Lakes Entrance is approximately 400 barrels per acre foot, or 11,600 barrels per acre; a 25 per cent recovery at least is expected.

Messrs. Avery and Anderson, in a review of information gained from Victorian Mines Department reports, show that 1 per cent by weight oil content of the glauconite would provide 4·55 gallons per cubic yard.

The summarized position is that recent carefully checked information has enabled a better knowledge and application of the field to be gained, Sir Edmund Teale's views, appearing in the same issue of NATURE (p. 31) being strongly supported by these later investigations.

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WHILE it is gratifying to learn these results, even so, the fact that we are dealing with an oil-water fluid and a rise of only 5 ft. per day does not indicate to me, at all events, that this is a normal crude oil or that there is a substantial hydrostatic head below it in the "glauconite" (oil horizon). Without all the current facts it is difficult to assess the real position in this field, but at least it is to be hoped that, whether developed by standard methods or otherwise, some good use may be made of what oil is ultimately won, even if no petrol or light distillates can be refined from it.

H. B. MILNER.

RESEARCH ITEMS

India's Population

IN a paper entitled "Half a Century of Population Trends in India", in the *Geographical Journal* of Nov.–Dec., 1941, A. Geddes has worked out the population density of the administrative districts of India from the censuses of 1881 and 1931 and has plotted for each district not only the percentage change (increase or decrease) but also the variability or deviation from any steady rate of change. This entailed an examination of the figures of the intervening censuses. This method brings out many important considerations. Thus in Bengal the east shows high increase, with very low variability, in contrast to the west, which shows arrest without variability, or a state of stagnation. Rice lands of the south showed slight variability whether there was arrest, as in the Cauvery delta, or high increase, as in the deltas of the Kistna and Godavari. Broadly speaking, arrest or stagnation seems to be the outcome of deficiency of necessities and endemic diseases, while strong fluctuations about the mean, which might be accepted merely as arrest, are characteristic of the famine tracts. This is not a condition of stability, though, as Geddes points out, a careless reference to census figures might suggest that conclusion.

Influenza *A* Virus

Leslie A. Chambers and Werner Henle, of the Department of Pediatrics and the Johnson Foundation for Medical Physics, University of Pennsylvania, described work on influenza *A* virus before the American Philosophical Society on November 22. The infectious agent of influenza *A*, as it occurs in emulsions of infected mouse lung, is associated with particles about 100 mμ in diameter. Particles of similar size, chemical composition, density, staining properties and electron-microscopic appearance are derivable from normal lung tissue. Virus contained in the extra-embryonic fluids of infected chick embryos is not associated with such large structures, but may be absorbed completely from such fluids by the particles derived from normal lung tissue. This, together with other evidence, indicates that a component of normal cells may act as carrier of a considerably smaller pathogenic agent. Concentration of the virus from extra-embryonic fluids was accomplished by precipitation with protamine. Analysis of the resulting infectious complex indicates that the virus consists largely, if not entirely, of nucleoprotein. Ultra-centrifugation at about 90,000 gm. for 9 minutes sedimented almost all the infective material from egg fluids. Sedimentation diagrams of the resuspended sediment showed two components to be present. One of these gave a well-defined boundary and had a sedimentation constant of 31×10^{-13}, corresponding with a particle size of about 12–14 mμ and a molecular weight of about 1,000,000. Fractionation by ultra-centrifugation, followed by protein analysis and infectivity tests, indicated that the heavier, less homogeneous component (S_{20} = about $800 \pm 100 \times 10^{-13}$) consisted, almost entirely, of aggregates of the smaller units. The two sedimentable fractions were infectious in approximately equal dilutions. A minimal infectious dose contained about 10^{-16} gm. and therefore consisted of less than a hundred particles. A size distribution curve based on measurement of electronmicrographs of the isolated virus protein showed the particles to be essentially spherical and to have a modal diameter of about 11 mμ. This is in good agreement with the estimate based on the sedimentation constant, $S_{20} = 31 \times 10^{-13}$. In view of this evidence, the virus of influenza *A* is regarded as one of the smallest pathogenic agents yet isolated.

Parthenogenetic Activation of Rabbit Eggs

HERBERT SHAPIRO, of Hahnemann Medical College, Philadelphia, described the parthenogenetic activation of rabbit eggs in the unoperated animal at a meeting of the American Philosophical Society on November 22. It has been shown in earlier work that cold is an effective agent in initiating artificial parthenogenesis in rabbit ova *in vitro*. By inducing rabbits to ovulate as the result of a course of pituitary extract injections, tubal eggs of known age could be cooled *in situ* in the anæsthetized animal, under sterile surgical conditions, by circulating cold water through a metal jacket into which the tube was inserted. This mode of treatment did in one instance lead to the birth of a normal parthenogenetic female, capable of normal reproduction. In the present series of experiments, rabbit eggs were activated parthenogenetically in the intact animal, without operating surgically. Rabbits were made to ovulate as usual by pituitary injections. Cooling of the entire animal was effected by applying an ice pack on the doe's flank, directly over the region of the Fallopian tube, as she lay anæsthetized on the table. Rectal temperature, respiration and pulse-rate were recorded at regular intervals. The uterine tube, which lies just under the abdominal musculature, was very likely brought to a temperature lower than that indicated by the rectal thermometer. Body temperature (normally about 39·7° C. in the rabbit) was lowered to points varying from 33·6° C. to 18·0° C. In all experiments, perfect recovery of the animals occurred. Eggs were secured at various intervals after the experiment by flushing the Fallopian tube, and they were then fixed and sectioned for microscopic study. Artificial parthenogenetic activation was obtained in two animals, one of which contained two eggs in the two-cell stage, when examined forty hours after the activating treatment, and another contained a young embryo in the early morula stage. More advanced stages in embryogenesis have not thus far been obtained.

Leaf-Curl Virus Diseases

THREE leaf-curl diseases of plants in South Africa have been described by A. P. D. McClean (*Sci. Bull.*, No. 225, Dept. of Agr. and Forestry, Union of South Africa. Govt. Printer, Pretoria. Pp. 66 ; 6*d*. 1940). Leaf-curl virus of tobacco causes a yellow network on the leaves, followed by projection of the smaller veins, and finally the formation of leaf-like enations, with malformation of the foliage. It has been transmitted by White fly to a considerable range of Solanaceous hosts, and does not appear to be transmitted by mechanical means. Separate leaf-curl diseases have also been described on petunia and hollyhock. The former virus has been transmitted by grafting to tobacco, *Nicotiana glutinosa*, and tomato. It forms enations but no chlorotic pattern upon tobacco, and induces petal-like outgrowths from the corolla of petunia. Leaf-curl of the hollyhock induces chlorosis and emergent veins, but no enations.

Detection of Lactose and Maltose by means of Methylamine

W. R. Fearon described before the Society of Public Analysts and Other Analytical Chemists on February 4 a simple test based on the observation that when alkaline solutions of lactose or maltose are heated with methylamine hydrochloride under prescribed conditions a bright violet-carmine colour develops. The test shows concentrations of the sugars down to 0·05 per cent. The carmine colour is not given by other carbohydrates or related compounds tested, or by proteins, fats or biological secretions, such as saliva or urine. Other reducing sugars may be coloured yellow by the hot alkali, and in excess they may interfere more or less with the test by combining with the amine.

Decomposition of Carbonic Acid

The evolution of carbon dioxide from bicarbonate by mixture with acid is usually supposed to go in two stages, a practically instantaneous ionic reaction $H^{\cdot} + HCO_3{}' = H_2CO_3$, followed by a unimolecular time reaction $H_2CO_3 = H_2O + CO_2$. By using a calorimetric method in which the two solutions undergoing reaction are driven into a mixing chamber and thence into an observation tube in which the temperature is measured at several points, F. J. W. Roughton (*J. Amer. Chem. Soc.*, 63, 2930; 1941) has shown that these two stages actually occur. The separate heats of reaction were determined over a range of temperatures and also the velocity constant of the second reaction. The values of the equilibrium constant, $[CO_2]/[H_2CO_3] = 950$ at 0°, and of the first true ionization constant, $a_H a_{HCO_3}/[H_2CO_3] = 2{\cdot}5 \times 10^{-4}$ at 0°, were also calculated. The heat of the ionic reaction was found to vary with temperature in a manner characteristic of weak acids.

Atomic Weights of Silver, Bromine and Potassium

In a study of the thermal decomposition of potassium bromate, with a precise correction for the moisture content of the salt, and the comparison of pure potassium bromide with silver by precipitation as silver bromide, R. K. McAlpine and E. J. Bird (*J. Amer. Chem. Soc.*, 63, 2960; 1941) have obtained new values for the molecular weight of potassium bromide and the atomic weight of silver; and from these, by application of the ratio of bromine to silver from the work of Baxter and Hönigschmid, values for the atomic weights of bromine and potassium referred to the new value for silver have been calculated. The atomic weight of silver found is 107·879, agreeing within 1 part in 100,000 with the present accepted value. The atomic weights of bromine and potassium calculated from this and the ratio Br : Ag = 0·740786 are 79·915 and 39·096, respectively. On the basis of the international value Ag = 107·880, the atomic weight of potassium would be 39·095. These figures provide an important check on the work of Hönigschmid and Sachtleben on the atomic weight of silver, in which the absence of moisture in the barium perchlorate and barium chloride used was proved only indirectly.

Lower Oxides of Boron

In 1916 Travers, Ray and Gupta showed that when the residue from the repeated extraction of crude magnesium boride with water was treated with concentrated ammonia in an atmosphere of hydrogen the solution contained a substance of the composition $H_{12}B_4O_6\ 2NH_3$, and when the ammoniacal solution is evaporated to dryness in a vacuum and gently heated, an oxide B_4O_5 remained, together with a small quantity of magnesia. R. C. Ray and P. C. Sinha (*J. Chem. Soc.*, 742; 1941) find that when the residue obtained by repeated and prolonged treatment with water of crude magnesium boride is kept in contact with successive portions of a fairly concentrated solution of ammonia in an atmosphere of hydrogen, and the filtrate concentrated in vacuum at room temperature, crystals separate from which, by fractional crystallization, two compounds, $(NH_4)_2B_2(OH)_2$ and $(NH_4)_2B_4O_6$, are obtained. When heated in a vacuum these formed powders of the oxides B_2O_2 and B_4O_5, respectively: $(NH_4)_2B_2(OH)_2 = B_2O_2 + 2H_2 + 2NH_3$, and $(NH_4)_2B_4O_6 = B_4O_5 + H_2O + 2NH_3$. The oxide B_4O_5 is perfectly colourless but B_2O_2 is slightly brown. The oxides are readily soluble in water, forming colourless solutions.

Sedimentation of Washed Red Blood Cells

The gradual development of biophysics is evident in occasional papers in the physical journals. A recent example comes from the Engineering Department of the University of Manchester, where R. B. Whittington has studied the sedimentation of washed red blood-cells (*Phil. Mag.*, 33, 68; 1942). The experiments were made as a first step towards a mechanical investigation of the red-cell sedimentation test, the sedimentation of whole-blood suspensions being too complex for direct mechanical study in the initial stages of the work. Although the red blood-cells approximate to elastic biconcave disks of diameter six times their thickness, they cannot be treated as non-biological material of the same dimensions. The suspending solution must be isotonic with blood-plasma. If the cells were suspended in a solution containing excess of salt they would shrink owing to loss of fluid by osmosis. A deficiency of salt would lead to swelling if not to rupture. Varying speeds of motion could not therefore be obtained by merely altering the specific gravity of the fluid unless it could be kept isotonic. Instead, a sodium chloride solution, 0·85 per cent by weight, was used throughout and the 'effective viscosity' was altered by varying the proportion of suspended cells. The drag-coefficients plotted logarithmically against the Reynolds' numbers gave a straight line graph.

Excessive Expansion of Dental Amalgams

Dentists have frequently been puzzled by an excessive expansion of dental amalgams. The normal expansion or setting is about 8 microns per cm. After 10–20 hours no further expansion should occur. Some specimens have, however, been found to expand more than two hundred microns in thirty days. The mystery has been solved by J. C. Schoonover and associates (*J. Franklin Inst.*, 232, 579; 1941). Records show that the excessive expansions occur only with alloys containing zinc and only in the presence of salt solutions such as NaCl. Gas pockets were found in such expanding amalgams, and the gas has been identified as hydrogen. Non-zinc alloys do not show this abnormal expansion, nor do zinc-containing alloys if they are amalgamated in a clean mortar or a mechanical amalgamator and are not contaminated by handling. The problem arose from the accidental introduction of NaCl from the perspiration of the palms of the hands of dentists when handling the alloys in the course of normal dental operations.

SEAWEED AS A FOOD FOR LIVESTOCK

By J. BEHARRELL

FACTS and figures concerning the extent to which seaweed in the form of a dried meal is incorporated in balanced rations for cattle, sheep, pigs and poultry are surprising and confirm the value placed upon seaweeds by the people of the Far East. Those who have lived in China know the value placed upon seaweeds. The Chinese import the dried product from the Pacific coast and use it daily as an important part of their diet; it forms one of the chief sources of supply of mineral salts. In the Hawaiian Islands more than seventy species of seaweed are reputed to have food value, but so far as is known no one has yet attempted to classify the world's Algæ, or even those of any country, according to their edible qualities. These appear to vary widely as to plants and in the parts of individual plants.

Among the most recent analysis of dried seaweed meals are those made in June 1939 by Dr. Bernard Dyer and Partners of London, which show the following:

	Norwegian	Scottish
Moisture	13·58	15·50
Oil or fat	4·40	1·50
Albuminoids	6·90	10·90
Digestible carbohydrates	53·95	35·30
Fibre	5·07	9·30
Ash	16·10	27·50
Mineral Matter		
Phosphoric acid	0·46	0·83
Lime	2·15	3·51
Magnesia	0·17	0·38
Sodium chloride	2·70	6·73
Soda in other forms	1·64	
Potassium iodide	0·07*	0·65†
„ chloride		4·98
Potassium in other forms	1·98	3·98
Iron oxide	0·10	0·32
Silica	0·20	1·40
Carbon dioxide, sulphur trioxide, etc.	6·63	4·72
Carotene	6·2	0·3 (parts per million)

* Equivalent to 500 parts iodine per million.
† Equivalent to 5,000 parts iodine per million.

While the analysis quoted gives the amounts of the major elements present—a spectrographic examination of the same product by the Macauley Institute for Soil Research carried out in March 1940 reveals the presence of sodium, calcium, magnesium and potash, with small quantities of barium, strontium and lithium and a trace of rubidium. Other elements observed in the ash were titanium, aluminium, iron, manganese, silicon and a trace of copper. The non-metals are not easily determined by spectrographic analysis, but the report states that copious iodine fumes were observed on ashing.

The concentrate, with the alkalis and alkaline earths removed, showed the presence of the following—quoted as parts per million of the original seaweed meal:

Cobalt	0·2	Vanadium	1
Nickel	10	Molybdenum	1
Tin	1	Gallium	0·5
Lead	1	Chromium	1
Silver	0·5	Lanthanum	10
Zirconium	3	Gold	
Zinc	40	Thorium	
Copper	10	Scandium	

The other trace elements mentioned are present in amounts of 1–10 p.p.m. but it was not possible to determine the exact percentages as no suitable standards were available.

This spectrographic analysis indicates the potential value of this product of the sea as a food for livestock.

Evidence of the value of seaweed for farm stock recently came from New Zealand (*Weekly News*, July 16, 1941).

The Laplanders feed seaweed to their cattle and so do the inhabitants of the Faroe Islands. In the Orkneys the magnificent stock is fed on seaweed as a proportion of their ration. At Stronsay in the Orkney Islands Laminaria is used. This is first dried by sun and air, being spread out thinly and treated as quickly as possible after being taken from the sea, otherwise it tends to decompose and is then unfit for stock feeding. Collection is made at all times of the year, but it is found by analysis that the iodine and mineral value is highest in the late summer and autumn. According to certain authorities it is an advantage to wash the weed and so remove any surplus salt.

The method employed in the north of Scotland is to dry the weed, and more particularly the long slender stipes (which are richer in iodine) by sun and air for several days, then to slice the latter by means of a special cutter, followed by a grinding process to reduce it to a fine grist.

This is finished on a rotary dryer—at a temperature varying from 350° C. to 450° C. for a period of forty minutes—and is later ground in the usual Christy and Norris type of disintegrator, when it is ready in fine meal form for blending in various types of feeding stuffs or in concentrates. The percentage used in the compound food is small, the usual rate being 1 per cent of the total food (by weight), but this can be increased to 2 per cent or slightly more with perfectly good results. Stock fed with this addition to their ration have increased stamina and a stronger resistance to disease. In the United States the Overbrook Dairy Herd, receiving dried seaweed meal in their ration, won the World's (Herd) Record for milk production.

A comparison between oats and a meal produced from dried *Laminaria flexicaulis* gathered on the coast of Brittany was actually made in a communication to the French Academy of Sciences in 1918. It gave the following figures:

	Oats	Dried Laminaria meal
Water	12·55	14·40
Carbohydrate matter	66·80	52·90
Nitrogenous „	9·10	17·30
Cellulose	8·45	11·50
Mineral matter	3·10	3·90

Results of feeding experiments gave 3 lb. of the meal as being equal in feeding value to 4 lb. of oats.

As 8–9 tons of fresh seaweed are required to dry down to 1 ton of fine meal, one million tons of seaweed would therefore produce the equivalent of 150,000 tons of oats, together with 1,200 tons of fertilizing material rich in potash.

It has been stated that in the islands of the Orkneys alone 30,000 tons of seaweed are available each year, so that the total quantity available round our coastline must be millions of tons.

With the backing of scientific research and practical feeding tests a vast reserve might be created to the great gain of our farmers and our stock feeders.

Present-day methods of gathering and processing by mechanical power might be improved—manufacturing costs, per ton, reduced to an economic level. There is evidence now that seaweed would provide food for farm animals in the years after the War, and profitable by-products for industry.

A considerable business has been created on the Californian coast to exploit the enormous jungles of giant kelp (*Macrocystis pyrifera*) which grows in the Pacific up to lengths of 500 ft. A machine mounted on a barge shears off the tops to a depth of three feet, which is the maximum permitted by the Government. Taken ashore, the kelp is treated in a similar way to that used in Scotland—dried in steam-heated or hot-air cookers, and ground to a fine powder, which must pass through a twenty-mesh sieve. The product is known as kelp meal and is mixed with a proportion of fish meal and sold as a seameal concentrate. Apparently not more than one tenth of the kelp meal harvested on the Pacific coast is prepared for stock food; all the rest is used for the extraction of iodine and for sodium salts.

The urgent need is for carefully checked records of the sea vegetation available, of the chemical value as a feeding stuff, for detailed digestibility trials, for the quantities required by stock to secure maximum results, and of its effect upon the health of all farm stock—a wide programme but one that should ultimately bring to agriculture thousands of tons of valuable home-grown feeding stuffs, from the sea-bed.

FORESTRY IN MALAYA

ONE reads with intensified interest the report of the progress of forestry in Malaya, now, we may trust for but a brief period, put to an end by the irruption of the Japanese. J. G. Watson, the head of the Forestry Department (if we omit the local inter-divisions of forestry administration of but little interest to the outside world), has written the "Annual Report on Forest Administration in Malaya including Brunei for the year 1940" (F.M.S. Govt. Press, Kuala Lumpur; 1941). In the report for the preceding year his predecessor, very fortunately as may now be thought, gave a valuable and interesting history of the growth of the Department from the year 1883 (see also NATURE, 148, 312; 1941).

In a general review of the year Mr. Watson mentions some small additional reservations of forest (347 square miles), bringing the total area of Government forest reserves to 10,879 square miles or 20·4 per cent of the total area. The actual area covered with forest of one type or another in Malaya is almost 77 per cent, 56·6 per cent of forest land being still unaccounted for. It is the existence of this mass of tropical forest covering the region which enabled the Japanese to penetrate so easily through the country.

Some interesting sylvicultural work was being undertaken, an all-Malayan regeneration *coupe* having been laid down for the conversion of inland forest. This annual *coupe* has been tentatively fixed at 12,088 acres; 1,000,000 acres have been set aside for this intensive management, of which 34,458 acres had been fully regenerated. The director of forestry says of this scheme that it is not yet fully operative in the more backward States where State land resources are still large. Differentiation between hard-wood and soft-wood areas is not possible as yet, but preference is given to those rich in the former. Eventual control will have to be on the basis of volume rather than area so far as hard-woods are concerned. It is sad to think that a certain proportion of this work will probably be lost, smothered by a victorious jungle of weed growth now that the attention of the forester will temporarily be no longer available. For those with a knowledge of the processes of growth in the tropical jungle are well aware that regeneration work of this kind can only be successful if carefully watched and given full assistance during the early critical periods. Already this work was becoming more difficult owing to the reduction of the staff through members joining the fighting forces.

This latter strain was, however, perhaps even more heavily felt in connexion with the timber industry and the numerous saw-mills of which there were eighty at work in connexion with the forests; fifteen of these mills are in the Straits Settlements (Singapore and Penang), forty-five in the Federated Malay States (Perak, Selangor, Negri Sembalin, Pahang) and twenty in the Unfederated States (Johore, Kedah, Perlis, Kelantan, Trengganu, Brunei). The combined outturn of all mills outside the Straits Settlements was 123,183 tons of 50 cub. ft. as compared with an estimate of 98,580 tons from Penang and Singapore. Apparently these two latter also saw up logs coming from Sumatra.

War conditions threw a heavy strain on the timber industry, which was (and, says the report, "will continue to be") hard put to meet emergency orders without dislocation of normal undertakings. The total outturn of logs was nearly 3,000,000 higher than the preceding year, the sawn timber running roughly each year at the same figure of 4,900,000 cub. ft. The one ply-wood factory produced 20,000,000 sq. ft. of three-ply sheets, and the four match factories seventy-three million boxes of forty matches apiece. The revenue from the forests during 1940 was 2¼ million dollars.

In spite of the absence of a number of officers detached to war duty, a certain amount of research work was continued throughout the year under various heads. It may be hoped, however, that when the department once again starts work in its forests more attention may be paid to preparing some working plans, the absence of which, in so advanced a department in many respects, is a curious anomaly.

If the annual report of 1940 is likely to be the last to be printed until the Japanese are sent out of Malaya, what can be said for the present prospects of the *Malayan Forester*, the December 1941 number of which has just been received?

An article on "The Contribution of Tropical Forests to War Economy", by H. E. Desch, wood technologist in the Forest Research Station in Malaya, is not without interest. In fact, it stresses without being aware of the fact, some of the dangers of the war exploitation of tropical forests already mentioned in NATURE. "A country rich in forests", says the author, "is obviously under an obligation to ensure that full use is made of its forests in War." This is undeniable, but it is just that "full use" in the case of the tropical forest which requires to be definitely understood. Too often the forest, at the mercy of the fellings of the timber merchant without expert supervision, has been ruined. The surprising demands which modern war make upon the forest are exemplified in a paper, "Forest Products and Defence", by C. P. Winslow, director of the U.S. Forest Products

Laboratory. To house a division of approximately 17,000 men in barracks requires 2,000,000 cub. ft. of timber; rather more than half if the men are quartered in a tent camp. Battleships are said to require 40,000 cub. ft. of timber and ocean transports 60,000 with an additional 300,000 sq. ft. of ply-wood, and so forth. The output of local sawn-timber and ply-wood in Malaya in 1940 has been already mentioned. Mr. Desch considered that the forests would be drawn upon to produce much larger amounts than that, and yet the forest service had already been called upon to allow a proportion of its gazetted staff to join the Forces. This was the position and in the absence of a recognition of the part played by the tropical forest in the economy of a country it appears probable that war demands would have similarly upset the good work which an excellent staff have been inaugurating during the past twenty years.

Mr. Desch regards this matter from the research and utilization point of view. His argument appears to be that the tropical forests of Malaya should be regarded as a source of sawn-timber and other produce for industries already existing in the country; but that their products should not be utilized for setting up, that is, supplying, the raw produce for new industries which, while interfering with the settled economy of the country, would require possibly new imports for their maintenance.

In how far the author's ideas would receive acceptance from the practical forest officer is open to doubt. But his ideas and these doubts must now remain for a future consideration.

SEISMIC PERIODICITY

THIS subject has been discussed by Archie Blake, who states that classical methods for detecting and measuring periodicity have suffered from two serious defects[1]. First, the Schuster periodogram does not provide adequately for non-sinusoidal types of variation. Secondly, the smoothness encountered in almost all time series and many other types of data introduces a spurious appearance of periodicity which vitiates the test of significance unless proper allowance is made for the smoothness. New statistics designed to detect effects not contemplated in the Schuster periodogram are being tried in a study of the series of aftershocks of the Helena Montana earthquakes of October 1935. This work is being done by use of punched cards, which greatly alleviate the labour of the computation.

In the case of two types of departure from randomness, such as periodicity and smoothness, each effect disturbs the statistics designed to detect the other. The only rigorous treatment is to study them together, but approximate methods (for example, that of Bartels) for discounting the effect of one type of variation in studying the statistics designed to detect the other may be very useful. Thus the accurate detection of periodicity demands a treatment of the problem of detecting, describing and measuring the smoothness exhibited by the series under test. This problem has been discussed by Bartels, Jeffreys and others, and from a different point of view by Shewhart.

[1] Progress Report on Periodicity and Time Series, by Archie Blake, Transactions of 1941 of the American Geophysical Union.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Friday, March 13—Saturday, March 14

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (DIVISION FOR THE SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE) (at the Royal Institution, Albemarle Street, London, W.1).—Conference on "European Agriculture: Scientific Problems in Post-War Reconstruction".

Friday, March 13

10.15 a.m.—"Measures for Reconstruction". (Chairman: Sir John Russell, F.R.S.)

2.15 p.m.—"Economic and Kindred Problems". (Chairman: Mr. F. L. McDougall.)

Saturday, March 14

10.15 a.m.—"The Future Betterment of European Farming". (Chairman: Dr. A. J. Drexel Biddle.)

2.15 p.m.—(Chairman: Sir John Russell, F.R.S.)

Monday, March 16

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. H. P. Rooksby: "X-Ray Technique in the Industrial Laboratory" (Cantor Lecture, 1).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Colonel Orde Wingate: "Geography of the Ethiopian Campaign".

Tuesday, March 17

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Ernest Marsden: "Recent Developments in the Scientific and Industrial Research Programme of New Zealand".

CHADWICK PUBLIC LECTURE (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Dr. William A. Brend: "Nervous Shock in Peace and War".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "Metals", 3: "Magnetic Properties of Metals".*

ROYAL STATISTICAL SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. R. G. Glenday: "Economic Reconstruction after the War".

Wednesday, March 18

OIL AND COLOUR CHEMISTS' ASSOCIATION (MANCHESTER SECTION) (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Dr. J. G. Gillan: "Some Aspects of Camouflage".

INSTITUTE OF PHYSICS (Joint Meeting of the LONDON AND HOME COUNTIES' BRANCH and the LONDON AND SOUTH-EASTERN COUNTIES' SECTION OF THE INSTITUTE OF CHEMISTRY) (at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Prof. H. Levy: "Social Implications of Science in War-Time".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 4.30 p.m.—Dr. H. Spencer Jones, F.R.S.: "The Atmosphere of the Planets" (Symons Memorial Lecture).

Thursday, March 19

INSTITUTE OF FUEL (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 2.30 p.m.—Dr. Ezer Griffiths, F.R.S., Dr. R. W. Powell, and Mr. M. J. Hickman: "Thermal Conductivity of Some Industrial Materials".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 6 p.m.—Dr. A. P. M. Fleming: "A Critical Review of Education and Training for Engineers".

Friday, March 20

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Sir Edward Appleton, F.R.S.: "Ionospheric Influences on Geomagnetism" (26th Guthrie Lecture).

APPOINTMENTS VACANT

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

LECTURER (MAN OR WOMAN) IN PHARMACEUTICAL SUBJECTS in the Plymouth and Devonport Technical College—The Director of Education, Education Offices, Cobourg Street, Plymouth (March 18).

TECHNICAL AND CONSTRUCTIONAL ASSISTANT in the Borough of Luton Electricity Undertaking—The General Manager and Chief Engineer, Electricity Offices, St. Mary's Road, Luton (March 20).

LECTURER IN ENGINEERING SUBJECTS in the Cardiff Technical College—The Director of Education, City Hall, Cardiff (March 25).

ASSISTANT DRAINAGE OFFICER to the Lancashire War Agricultural Committee—The Executive Officer, Institute of Agriculture, Hutton, Preston (March 28).

COLLOID CHEMIST OR PHYSICIST—The Director of Research, British Pottery Research Association, Queens Road, Penkhull, Stoke-on-Trent.