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Science and Labour.

A FORTNIGHT ago the British Association was in session at Cardiff, and men of science were engaged in making and discussing contributions to the world's store of natural knowledge. This week the Trades Union Congress meets at Portsmouth, and representatives of manual labour are asserting their industrial and political claims with no uncertain voice. The spirits of the two bodies are as the poles apart. On one side we have the explorer, animated solely by zeal for discovery and eager to learn of new fields in which pioneers are prospecting: on the other we have workers seeking—no doubt reasonably in some cases—full rights and privileges for particular occupational interests, and aiming to use these interests for political power.

It is not within the province of NATURE to discuss these ambitions of manual labour, or to anticipate the effects of a policy which, to say the least, has little constructive work behind it. We may, however, deal appropriately with the relations of science to labour, especially as the activities of both are essential to human progress and prosperity. Schemes for securing greater pay for less labour occupy most of the attention of the public Press and social platform, while the vastly more important subject of the creation of wealth through scientific discovery and industrial application is almost unheeded by the very people who profit most by it.

Labour alone may build pyramids to-day, as it did four thousand years ago, but it cannot create new industries without new knowledge, and this is obtained by scientific research, whether carried on in an academic laboratory or in the works. Without the aid of science and invention, this country would be in the condition of China, where four-fifths of the population are peasant cultivators of the soil, and the social condition of the people is far below that of any British working class. The fullest encouragement must, of course, be given to the greatest of our industries—agriculture—but it should also be remembered that there are only about as many acres of permanent pasture and arable land together, in the United Kingdom, as there are people in this kingdom, and that we must depend largely for our existence upon foreign trade. By the use of our knowledge and the development of our natural resources we have to be able to offer other countries what they are not yet in a position to produce for themselves, for the lack of either one or the other of these factors of prosperity. Resources can be exhausted, but scientific discovery can continually provide new openings for industry, and the nation which makes the best use of it can be assured of a leading position for its products in the markets of the world.

When, about the end of the eighteenth century, the home demand for corn exceeded the home supply, the population of England and Wales was about nine millions: now it is about forty millions, and we have to look to improved methods of cultivation, and to the production of new varieties of wheat, to enable us to provide more than a week-end supply of food. As a large and progressively increasing proportion of the world's inhabitants feed upon wheat, markets from which we now obtain supplies will also have the demands of other countries to meet, and it will be necessary for us to grow more of our own, as well as to produce goods which other countries will purchase from us.

We now export textile goods to the value of nearly three hundred million pounds annually, and we are able to do so, not because of any specific aptitude on the part of the British manual worker, but because of machinery and of chemical industry, which produces the dyes required for piece goods. Fifty years ago nearly all the cotton grown in the United States was exported to Europe: now, every year more and more raw cotton is being used in the mills of the New England States, and we have to seek fresh sources of supply for our raw material. India is also developing its cotton industry to supply its own needs, and the tendency must always be in this direction when a country concerns itself with progressive industry. China has not yet reached this condition, and therefore it exports raw cotton, wool, and silk, and imports textiles made from them. We are able to send into China cottons and woollens to the value of about ten million pounds annually, solely because we are in advance of that country in science and invention.

We have reached our position as a great industrial nation by the use of scientific knowledge, and we cannot go back to the time when domestic manufactures and home markets were our only concern. China is rich in the very natural products to which our country largely owes its prosperity, and through which a large part of the population secures profitable employment. There is enough coal in the province of Shansi alone to last the world for several thousand years, yet China has not benefited from its riches because of its indifference to progressive knowledge. Two hundred years ago we were in much the same condition. At that time the total quantity of coal raised in Great Britain was not more than a few thousand tons, whereas now the annual output approaches three million tons. Our early coal mines were not more than about 180 ft. deep, and it was the invention of Newcomen's pumping engine that enabled the depth to be extended to about 300 ft. Now, thanks to Watt's steam-engine, and modern methods of ventilation and coal-getting, shafts can be sunk and coal seams worked at ten times this depth. Our buried treasure would have remained hidden in the bowels of the earth to this day, and the million or so miners who derive their living from them would be without an occupation which owes its growth entirely to the steam-engine and other machinery which science and ingenuity have provided.

These workers now number about 5 per cent. of the occupied persons in this country, and they threaten to hold up most of the nation's industries unless certain demands they make are granted. Whether their peremptory action can be justified or not we will not attempt to discuss, but we do ask them to remember that they owe their occupational existence to science, and that men of science really hold the key of power to all industrial positions. A few hundred chemists engaged in dye manufacture, or a few thousand in the production of sulphuric acid, could paralyse almost every industry if they adopted the action by which the coal-miners now challenge the Government of this country.

The closing of the coal mines would mean the stoppage of our iron and steel trade, upon which our industrial greatness has been built, and here again the industry owes its modern development to such men of science as Sir Henry Bessemer, Dr. William Siemens, and Sir Robert Hadfield, to mention three only. Iron ore occurs in China almost as widely diffused as coal, but it is a talent buried in the ground, and the country derives little profit from it, either in employment or in power. The Chinese possess to a supreme degree the conservative spirit which opposes all advance or change, and we should have remained in their position if vested interests, either of employer or of employed, had been permitted to control national development, and industry had failed to take advantage of scientific discovery. Manganese and nickel, titanium, molybdenum, tungsten, vanadium, and other elements now used in steel-making were all products of scientific investigation, and from them wealth has been created and work provided.

It would be easy to show that science has been the source of development of our chief industries and that a single scientific discovery, like that of magneto-electricity by Faraday, for example, contributes far more to human progress than the action of all the politicians and labour leaders put together. The discovery of thorium and cerium made possible the manufacture of incandescent gas mantles, of which about four hundred millions are now produced annually, and from osmium and tungsten have developed the great production of metallic filament lamps. Aluminium, discovered in 1827, has risen from the position of a rare metal to a yearly tonnage exceeded only by iron, lead, copper, zinc, and tin, and it is manufactured exclusively by electrolytic methods, which would never have come into existence but for the investigation by men of science of the chemical effects of the electric current.

The workers are now strong enough to exact their fair share of the profits arising out of the applications of science, and no one wishes to dispute their just claims in this respect. In their deliberations, however, they should occasionally show that they realise the part which science plays in opening up new fields of work without itself sharing in the distribution of the wealth it creates. Probably, if there were a complete levelling of all incomes, wage-earners would not benefit by more than about 5 per cent., yet this is the subject upon which attention is mostly concentrated, while the means of increasing the amount of wealth to divide by creating new industries or increasing the output of individual workers are given little consideration. It should be obvious that the greater the value of industrial production through science and labour, the more will be the profits to be shared, and that the curtailment of productive capacity must mean eventual disaster. The Labour Party has stated that it "has the duty of placing the advancement of science in the forefront of its political programme." We look to it to justify this claim by presenting to the workers in true proportion the relative values of participation in profits and the creation of wealth through science, as determining factors of social improvement and industrial progress.

Development of Higher Education in India.

THE fact that applications are now being invited for seven professorships and five readerships in the University of Dacca will perhaps direct increased attention to the latest development of higher education in India. It is certainly most desirable that the scientific world at home should take an interest in the subject, and do everything possible to help in a movement that is unquestionably of Imperial consequence. For this new university is intended to mark an important departure; it is to be of the residential and teaching type, and both in its government and in its ways is to embody, so it is hoped, what is best in our universities, old and new, at home. The standard of admission of students is to be what is customarily the intermediate examination.

All who have first-hand knowledge of Indian universities, and many of those who have only indirect knowledge, will know how urgent is the need for reform. The situation easily admits of scathing criticism, but it will be more profitable to assist to the extent of our opportunities in this new constructive effort. No more need be said here of the past than that we have in India exactly what we might expect from the attempt to implant in the East, under Government auspices, a system of universities modelled on the London University of early Victorian days. We know at home to what degree our statesmen have been gifted with educational insight and how far their training has qualified them to adjust educational policy to the needs of a new age or of a different race. Those who wish to read in detail the story of Indian university development will do well to refer to the report of the Calcutta Commission, which was noticed at length in these columns on its publication last year (vol. civ., p. 357).

Dacca, as the ephemeral capital of Eastern Bengal, is well provided with all the material elements for making the university a success, and the Bengal Muslims declare themselves intent upon educational advance. If at the outset an academic staff can be assembled that will hold firm to the professed aims of the new university, it may succeed in conferring an incalculable boon upon India. The terms of the appointments will, it is to be hoped, prove sufficiently good to attract men of the necessary quality. A professorship at its best begins at about 1200*l.*, rising by annual increments of 60*l.* to 2160*l.*, and in addition there may be an allowance of 600*l.* a year. The normal age of retirement is to be fifty-five, when the benefits of a provident fund will accrue.

At the present time there will no doubt be more than the usual difficulty in recruiting first-rate university teachers for India. The abnormal demands of the home universities and the unsettled state of the world come into reckoning, in addition to the usual considerations of exile and climate. On the other hand, there is ground for expecting that in future those who take up educational service in India will not be penalised to the extent they have been in regard to promotion to appointments at home. It is to be hoped that the appointments at Dacca will be seen to afford a very special opportunity of national service and a true educational mission, and that they will appeal not so much to the spirit of adventure as to a real ardour for the advancement of learning by high and creative scholarship. The realisation of the aims of the new university, and the establishment of a compelling example that will lead others to mend their ways, will make a demand on the strength of character and fidelity to principle of its first professors not less than on their intellectual competence. There is surely much here to attract the best type of both character and talent.

As already announced, the first Vice-Chancellor of the new university is Mr. P. J. Hartog, lately Academic Registrar of the University of London. Distinguished in early days as a lecturer in chemistry at Manchester, and most recently by his leading part in the establishment of the School of Oriental Studies in London, Mr. Hartog will approach his task with ample breadth of intellectual sympathy. As a member of the Calcutta University Commission he gained direct knowledge of

Indian university conditions, and co-operated in designing the new institution of which he is to be the chief academic officer. His abundant experience, gained amid the conflicts of London University, will be invaluable for his new duties, for it is the transformation of examining into teaching universities that constitutes the central problem in India. If the difficulties have been great at home, they are still greater there. Nothing seems so urgent, among all the ills that afflict Indian education, than that the strangling grip of university examinations should be released from the throat of learning.

It is true that under the strong and persuasive influence of the Calcutta Commission the aspiration for university reform has received a large measure of native assent, and this is no doubt quite sincere. But the currents of an evil tradition are strong and deep; rights and privileges of very serious social import have become established; a suspicion is apt to arise that attempts at reform are attempts to restrict and deprive, and that they are actuated by a desire to check, rather than to aid, the advance of that kind of learning which will best help the Indian to progress and self-dependence. This hovering distrust will assuredly attend the early labours of Mr. Hartog and his colleagues, but even if they cannot move far towards realising "a fresh synthesis of Eastern and Western studies," which is the stated ideal of their university, they may, with good fortune, inaugurate a salutary and far-reaching reform.

The Foundations of Aircraft Design.

Applied Aerodynamics. By G. P. Thomson. Pp. xx+292. (London: Hodder and Stoughton, Ltd., n.d.) Price 42*s.* net.

MR. THOMSON has made no mention of his own share in the work which he describes, but it is common knowledge that the development of experimental methods, more particularly in full-scale research, owed much to his initiative during the war. At one period, as a member of the experimental staff of the Royal Aircraft Establishment, he took an active part in the now historic debate on "scale effect": at a later date he joined the staff of the Aircraft Manufacturing Company, and there obtained first-hand acquaintance with the routine of a commercial design office. Such varied experience, combined with a considerable amount of actual flying, constitutes the best possible qualification for authorship of a text-book on the practical applications of aerodynamic theory, and the present volume, as we should have expected, abounds in happy illustrations of the interaction of constructional and aerodynamic considerations in design; but it does not of itself tend to ensure clear and systematic presentation of results, and we believe that by devoting a longer period to deliberation and planning Mr. Thomson could have produced a better book.

Let us confess at once that we have found it quite exceptionally difficult to form our judgment of this volume, and that we may have had a wrong idea of the class of readers for which it is primarily intended. Mr. Thomson's preface is not very explicit on this point, but taken in conjunction with Col. O'Gorman's introduction it certainly seems to suggest that he has catered principally for the designer, whilst keeping in view the needs of R.A.F. officers training; in other words, that his book is intended both as a work of reference and as a manual of instruction. But if so, then form and arrangement, we cannot but think, become matters of very real importance, and it is on this score that we venture the foregoing criticism. At our first reading of the text, the difficulties which confront the student impressed us so much as almost to obscure its very real merits; and although on a second examination we were able, with our acquired knowledge of the whole book, to appreciate and enjoy the author's success in compressing so much valuable material into some 280 pages of large type, we cannot help thinking that our first impression was more representative of the view which an uninitiated reader would obtain. We suspect that Mr. Thomson, when he wrote, was too close to the work which he describes to be able to see his subject from the point of view of his readers.

The student, for example, who comes new to the subject ought always to be given the definitions of special terms and the meanings of special symbols used *before* he meets them in the course of the argument: he ought not to find casual references to "interference" scattered throughout chap. iii., and yet be denied a definition, even by implication, of this term until he reaches the very end of the chapter; nor ought he in chap. x. to find himself suddenly confronted by symbols to the meaning of which he is given no clue, save a general reference to two chapters in the second part of the book. In our experience, much of the difficulty of aeronautical literature consists in the sheer number of the symbols which it is found necessary to employ, and we would gladly exchange the glossary of aeronautical terms, which forms an appendix to this volume, for a tabulated list of symbols and their meanings—more especially now, when an excellent scheme for standardising these has been evolved by the Royal Aeronautical Society. The designer who will use the book as a work of reference doubtless has a better initial acquaintance with its notation, but since he will require to read the book piecemeal we suspect that his difficulties will be very much the same. For him it is most important that each several argument shall be as far as possible self-contained, with assumptions clearly stated at the outset. Now in some sections of the chapters on stability we can almost feel Mr. Thomson developing his thought as he proceeds: the discussion of a problem is begun with insufficient data; the scarcity becomes apparent as the analysis proceeds; assumptions have to be made, and are made, sometimes with little justification other than that of necessity. The sequence is typical of engineering as distinct from purely scientific investigations, since "engineering" (we believe the modification of Samuel Butler's epigram is due to Prof. Unwin) "is the art of drawing sufficient conclusions from insufficient premises": but it is not a suitable arrangement when the results of these investigations come to be "written up" for the practical man, who is apt to become bewildered by the steady accretion of assumptions, and even to be doubtful, at the finish, whether any new result has been obtained at all.

One feature of this book will, we believe, be of the very greatest service to its readers: there are practically complete references to original sources of information, even in instances where the reports quoted had not passed from the type-written to the final form at the time of writing. (Incidentally, their authors' names are somewhat frequently misspelt.) The advantages of this information will be apparent to every serious reader, and of immense service to the designer. The book's own index is not equally successful; at all events, we have not found it of much assistance in compensating for the faults of arrangement which we have noticed above, and of which other instances might be given—such as the inclusion of actual experimental data, and of a carefully reasoned plea for further experiments on body-resistance, in a chapter ostensibly dealing with experimental methods, of a paragraph and three diagrams bearing on the distribution of forces between the upper and lower planes of a biplane under the chapter heading of "centres of pressure and wing-moments," and of Fig. 94, an illustration of experimental apparatus, in a chapter which otherwise is devoted to the discussion and application of experimental data.

We have failed in our intention if the foregoing criticisms suggest that we consider this an unsound or a carelessly written book; on the contrary, we are convinced that readers who have had some first-hand acquaintance with the work of which it treats will read it with real pleasure—and, after all, no better proof of its excellence could be adduced. Our only reason for thus emphasising the importance of arrangement and presentation is that we hope soon to see a second and revised edition in which these aspects have received greater attention: very little labour, we believe, would be required to make this work as satisfactory, regarded as a text-book of design, as it already is in essentials, whereas the impression which it will make upon the ordinary reader as it stands is not likely to do justice to its very real merits.

Food Poisoning.

Food Poisoning and Food Infections. By Dr. William G. Savage. (Cambridge Public Health Series.) Pp. ix+247. (Cambridge: At the University Press, 1920.) Price 15*s.* net.

THE subject of this work is one not only of great importance in medicine, but also of much scientific interest. It necessarily covers a very wide field, for the production of disease by food may depend upon any one of a large number of different conditions. A food may be inherently poisonous, or its ill-effects may depend upon some abnormal sensitiveness on the part of the consumer; it may acquire poisonous properties as the result of putrefactive or other chemical changes on keeping; it may become the vehicle of metallic poisoning from contact with containing vessels, or of bacterial infection resulting from animal disease, or from subsequent contamination with pathogenic organisms. Dr. Savage has rendered a great service, alike to medicine, to public health, and to pure science, in gathering together in a small volume the most recent and authoritative information upon the various ways in which health may be prejudicially affected by food. There is no one who could more fittingly have undertaken the task, for the subject is one of which he has a wide practical experience, and which he has made peculiarly his own. So well has he done the work that scarcely any unfavourable comment suggests itself, and a review must take the form, most pleasant to the reviewer, of a short account of the way in which Dr. Savage has treated his subject.

The first chapter is occupied by a short historical review, and the author then passes on to animal infections transmissible to man, a subject which, apart from the group of diseases due to Gärtner's bacillus and its allies, is dealt with briefly as not falling within the proper scope of the book. In discussing food as a passive vehicle of infection, Dr. Savage gives a very useful summary of experimental work on the temperatures reached in ordinary cooking. Many readers will be surprised to learn how inadequate ordinary boiling and baking are to destroy bacteria in the deeper parts of a large joint of meat, and how little reliance can be placed on cooking as a safeguard against infection. Foods inherently poisonous are the subject of the next chapter: poisonous fish scarcely occur in this country, but an adequate account is given of the effects produced by certain fungi, and of ergotism and lathyrism. Food idiosyncrasy is then discussed: the writer accepts the view, now usually held, that this is a question of anaphylaxis. Certain persons may be so abnormally sensitive to a particular foreign protein as to react against it, with symptoms recalling those of anaphylactic shock, even when it is taken by the mouth—a view which presupposes that some minimal amount escapes digestion and reaches the blood unchanged. The commonest protein against which such hypersensitiveness is exhibited appears to be white of egg, but even milk may be thus poisonous to certain individuals.

The largest section of the book is naturally devoted by the author to those outbreaks of acute gastro-enteritis so commonly described in the newspapers as "ptomaine poisoning," but which are now well known to be instances of infection with some member of the Salmonella group of bacilli. Here Dr. Savage is on his own ground; his report to the Local Government Board on this subject in 1913 is well known. The symptoms, mode of causation, pathology, and bacteriology are fully discussed, and a table is given of 112 outbreaks in this country, with the chief known data concerning each. (It is a pity, by the way, that Dr. Savage persistently uses "data" as a singular instead of as a plural word.) The bacteriology of the Salmonella group is an extremely interesting, but a very difficult, subject. We do not know whether the different food-poisoning bacteria are mere races of one type, or deserve the rank of separate species; it is a most puzzling thing that a single organism should be the cause of paratyphoid fever as a rule, and yet at times produce a gastro-enteritis which is clinically a quite different disease. Into this thorny question Dr. Savage scarcely enters, though he gives an excellent account of the known facts as regards both human and animal infections, together with a full and useful bibliography of the "Gärtner group." It is unfortunate that in many outbreaks of food-poisoning the bacteriological examination has been so insufficient that no certain facts can be gleaned, but the full instructions given in these pages should enable any bacteriologist to carry out an investigation on adequate lines.

Other forms of bacterial food-poisoning receive full discussion, but the weight of evidence seems against their importance, if not against their existence. Botulism, of course, is a well-known condition on the Continent and in America, and receives a chapter to itself. Special types of food-poisoning, such as those due to mussels, cheese, and potatoes, are also dealt with in a separate chapter, and seem to be chemical in their origin.

In a discussion on putrefaction an excellent popular account is given of the chemical and bacteriological aspects of that process, and Dr. Savage has no difficulty in laying the bogey of ptomaine poisoning. This hypothesis dates from a time before the rise of modern bacteriology; ptomaines are unquestionably formed during putrefaction, but their toxicity has been exaggerated, and they are present in any quantity only "when the food is far too nasty to eat."

Chemical poisons in food, unintentionally introduced, are dealt with under two headings—that in which they are introduced in processes of manufacture, and that in which they arise from the chemical action of the food upon the tins or other vessels in which it is put up; a further group is formed by the preservatives used to prevent secondary bacterial action. These subjects are treated in adequate detail, and in conclusion there is a chapter on the prevention of food-poisoning. The book is compact, well printed, and adequately indexed, and should be of signal service to the medical profession and to all engaged in public health work, while it is a mine of information to the bacteriologist, and so clearly written as to be of no small interest to the general reader.

Malaria at Home and Abroad.

Malaria at Home and Abroad. By Lt.-Col. S. P. James. Pp. xi+234. (London: John Bale, Sons, and Danielsson, Ltd., 1920.) Price 25*s*. net.

COL. JAMES'S book appears at an opportune time, when malaria, owing to the Great War and the return of soldiers from highly malarious countries, has acquired a much wider distribution than before. How wide that distribution is at the present time is seen on the map of the world in the frontispiece, and how it affected England in 1919 is shown on map 59, p. 90. It appears that since March 1, 1919, when notification of malaria became compulsory in this country, no fewer than 14,000 demobilised soldiers were, up to November, 1919, notified as suffering from relapses. These figures alone show the importance of the subject at home, while it is no less so abroad, for it is well known that malaria has become even more prevalent abroad than it was when Sir Ronald Ross made his epoch-making discovery as to the *rôle* of the mosquito in the spread of the disease, and wrote his classical work on its prevention.

Col. James has had a large experience of malaria in its endemic and epidemic forms, and he evidently possesses the gift of being able to impart his knowledge in an interesting way.

Lucidity and the maintenance of interest are essential in a book of this kind, for otherwise the many facts and details set forth in connection with the causation, spread, clinical features, pathology, diagnosis, treatment, and prevention of the disease would appeal only to a few specialists, whereas we hope this book will be read by every medical man and by our administrators in tropical countries. The volume is divided into ten chapters. The first is devoted to the life-history of the parasite and to the mode of spread of the disease; the second to the factors concerned in the spread of malaria. The next two chapters deal with the practical work necessary for inquiry into malaria, followed by chapters on a malarial survey in England and the tropics, and epidemiological observations in each. The remaining four chapters give an account of the symptoms, pathology, diagnosis, treatment, and prevention and eradication of malaria.

The illustrations number 104. They are a feature of the book, and very helpful to the reader, leaving less to the imagination than many other monographs. For instance, the photographs depicting the rot-holes in trees; roof gutters with blind ends where water lodges; cut bamboos and a common water plant are likely to give a truer and more lasting impression regarding the nature of certain breeding places of larvæ than any long description.

When giving an account of the clinical onset, course, and termination in ordinary cases of malaria, Col. James very properly points out that the primary illness does not always commence with very characteristic symptoms and signs, and he remarks that an atypical onset has been observed so frequently in primary cases of malaria contracted during the war that it is advisable to keep in mind the possibility of malaria as regards almost every illness in which, after proper clinical examination, some doubt as to the diagnosis remains. This requires to be borne in mind in view of the frequency with which soldiers who have served in the war have not suffered from their first attack of malaria until after their return home. This warning is repeated when describing the pernicious symptoms which may appear in infections with the malignant tertian parasite, and more rarely with either of the other two species of parasites. In such cases there may be in a patient who is obviously very ill an almost complete absence of what are known to be the usual clinical signs of malaria, and unless the blood is examined the malarial attack may be mistaken for sunstroke, alcoholism, acute heart failure, dysentery, cholera, appendicitis, etc. It is because of the protean character of this disease that Sir Patrick Manson, to whom this valuable book is dedicated, states in the preface that "no man has a right to practise in malarial countries or as a consultant in this country who cannot use his microscope in the diagnosis of malaria and other blood parasites."

The Oil Industry.

Animal and Vegetable Oils, Fats, and Waxes: Their Manufacture, Refining, and Analysis, including the Manufacture of Candles, Margarine, and Butter. A Practical Treatise. By Dr. Geoffrey Martin. (Manuals of Chemical Technology, ix.) Pp. x+218. (London: Crosby Lockwood and Son, 1920.) Price 12*s.* 6*d.* net.

SINCE the death of Dr. Lewkowitsch there have appeared quite a number of books on the oil industry, mainly based on his work. The present volume shows the advances made, inasmuch as more attention is devoted to recent industrial developments. Dr. Martin has produced a very valuable compilation of recent patents and improvements, which is well worth the perusal of anyone interested in the oil industry. Excellent chapters on the extraction (including that from waste products), refining, and hydrogenation of oils and fats, and on the candle industry, are given with profuse illustrations. Perhaps too much stress is laid on the volatile solvent process for the extraction of seed oils. Up to a few years ago oils extracted by this process were rarely to be found on the market, due no doubt to the difficulty found in the filtration of the extracted oils.

Coming to the general and analytical sections of the work, we do not find these entirely up to date. The portions dealing with linseed oil (oxidised and polymerised) and with the action of driers take no note of the recent work of Morrell, Ingle (J.S.C.I., 1911 and 1913), and Mackey (J.S.C.I., 1916 and 1917). Under linoleum the author states that linseed oil can be blown in five or six hours, whereas to obtain a suitable product, in our experience, eighteen to twenty hours are necessary. Also in the manufacture of linoleum cements he mentions an amount of kauri gum which is far in excess of that required. His assumption that in the blowing process (Wood and Bedford, and Walton) "superoxidised oil" is formed has not as yet been proved (see Ingle and Woodmansey, J.S.C.I., 1919, p. 101). Otherwise the brief description of the linoleum industry is good.

In discussing the oils used in the cloth trade, while the preparation of distilled oleines, etc., is well treated, the testing of them with regard to their application is too brief. We do not find any reference to the Mackey oil tester, and little mention of the danger of spontaneous ignition or other fire risks.

The analytical chapter is all too brief, though for the most part well done. The present writer has shown (J.S.C.I., 1902, p. 587) that Hubl's solution should be used fresh, and not after twenty-four hours' mixing, as Dr. Martin, copying Dr. Lewkowitsch, states. With regard to the preparation of Wijs's solution, Dr. Martin includes the method from iodine trichloride, a product of doubtful purity, and in this he follows the recommendation of the Government Committee of Analysts (Ministry of Food), but he also gives in the chapter the more trustworthy method by the saturation of glacial acetic acid solution of iodine with dry chlorine. Also one misses the details of the valuable hexabromide test.

With regard to the edible qualities of hydrogenated oils as compared with natural fats, such as butter and lard, it may be pointed out that the assumption of a continuous carbon chain in all the fatty acids has not yet been proved. It is probable that some of the unsaturated oils contain "branched chains" (Verzeigte Ketten), and so in hydrogenation isomeric stearic acids may be formed, and these may have quite different digestibility. Hence it does not follow that a stearine produced by hydrogenation would have the same food value as a natural fat.

The author reprints reports of the Government Committee of Analysts (Oils and Fats Branch, Ministry of Food) which we consider so inadequate that it is surprising that Dr. Martin gives them space.

On the whole, the work should prove of great assistance to the student of the industrial developments of the oil trade, but to the chemically minded it does not go far enough into the discussion of the application of scientific principles and tests to the industry. HARRY INGLE.

Science in History.

Transactions of the Royal Historical Society. Fourth Series. Vol. xi. Pp. v+247. (London: Royal Historical Society, 1919.)

TO scientific readers the most important communication in this volume is that by Sir Richard Gregory, entitled "Science in the History of Civilisation." There are, the author tells us, two methods of approaching the history of science—that of the specialist, who regards it purely as growth of the knowledge of material objects and phenomena in the course of time; and that of the historian of human culture, who dwells on its influence upon social and economic conditions. The object of this paper is to plead for a closer co-ordination of these separate points of view in works of general history. This has been attempted to some extent by Voltaire, Buckle, and Lecky, and in more recent times by Mr. and Mrs. Whetham and by Mr. F. S. Marvin; but some modern speculations have served only to darken knowledge. The late Mr. B. Kidd traced the cause of the evolution of society to the continuous action of religious beliefs, but Dr. Russel Wallace pointed out that the doctrine of progressive ethical impulse does not explain how the rude struggles of 2000 years ending in the sixteenth century could have tended to increase and develop the altruistic and ethical sentiments of early races in their struggle for existence.

The true age of science dates from the era of experimental investigation, advocated by Roger Bacon and advanced by Galileo and the men of his age. It is the scientific scepticism thus created which is responsible for the growth of knowledge and its effects to which all material advance is to be attributed. The question for the future is how to use rightly the power which science gives to modern man; not to teach it as a jumble of isolated facts and theories, but in the history of its development from the earliest times. The necessity of paying increased attention to the history of science has been urged by Sir J. J. Thomson's committee on the position of natural science in the educational system of Great Britain; and on the research side a group of students working with Dr. C. Singer at Oxford has produced the first volume of "Studies in the History and Method of Science," while a second is in the press, to be the basis, it is hoped, of a comprehensive "History of Science," on lines similar to those of the "Cambridge Modern History." This new movement is ably advocated in the paper under notice. C.

Our Bookshelf.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. ii., parts 8–10. Vol. iii., parts 1–8. Vol. iv., parts 1, 3, 5–10. (Parts xviii.–xxviii., xxxi., xxxiii., xxxv.–xl. of the complete work.) (Sydney: W. A. Gullick, 1913–20.) Price 2*s.* 6*d.* per part.

AUSTRALIA, with an approximate area of 3,000,000 square miles, exhibits many peculiarities in its flora, one of which is the presence of large genera distributed practically throughout its full extent. Noteworthy among these are Eucalyptus and Acacia. Eucalyptus comprises species presenting the largest trees of the country down to dwarf bushes. Mr. Maiden's critical revision of the genus Eucalyptus, of which the first part was published in 1903, is now, we believe, approaching completion with the fortieth part. Nearly twenty years is a long time to wait for the termination of a work so greatly needed, yet the author may well be excused, considering his multifarious duties as director of the Botanic Gardens and Government domains; but it is a case of "better late than never." In spite of the pressure of other matter, the author and Government printers succeeded in publishing fourteen parts during the actual war period.

For the purposes of this monograph Mr. Maiden visited Europe to compare his materials with the type-specimens of the species published by earlier European botanists. In fact, he spared himself no trouble to reduce the complicated synonymy of certain species. How far he has succeeded can be discovered only by the student of his great work.

Mr. Maiden defines and figures upwards of 200 species. His illustrations are not artistic pictures, but they are something better, as they represent the specific characters, and are excellently drawn. For example, the leaves of many species of Eucalyptus present a great variety in form in the same species and even in the same individual. The seed vessels, too, differ considerably in shape in different individuals of the same species. These peculiarities are faithfully reproduced, and the origin of each figure is carefully indicated.

Following the descriptions is a more or less lengthy list of specimens belonging to the species in question. Full synonymy, with references to the place of publication, is given, and we understand that the author will deal with the classification of the species, of hybridity, and of other questions concerning the genus in a later part.

W. BOTTING HEMSLEY.

Annual Reports of the Society of Chemical Industry on the Progress of Applied Chemistry. Vol. iv. 1919. Pp. 632. (London: Society of Chemical Industry, 1920.) Price 12*s.* 6*d.* (non-members).

THE first three volumes of the annual reports on the progress of applied chemistry, issued by the Society of Chemical Industry, suffered from the stress of war conditions under which they were produced, and were inevitably incomplete in some respects. In the volume for 1919, the fourth of the series, the publication committee has, however, achieved its purpose of preparing a complete conspectus of progress in the various branches of applied chemistry. Moreover, some of the gaps which occurred in previous volumes have now been filled up. The subject of explosives is dealt with for the first time, the extremely interesting and valuable report covering the period from the beginning of the war until the end of 1919. The reports on ceramics, building materials, and fermentation for 1918, which had to be held over, appear together with the reports for 1919, and a section dealing with analysis, which was omitted from previous volumes, is also included.

The volume includes reports on progress during 1919 in practically all branches of chemical industry. The reports, although of necessity condensed, are generally both comprehensive and complete, and the authors are to be congratulated on the success with which they have accomplished their laborious tasks. The volume will undoubtedly be of the utmost value to technologists, and may fitly find a place on the library shelf beside the annual report of the Chemical Society, to which it is complementary.

Cotton Spinning. By William Scott Taggart. Vol. iii. Fifth edition. Pp. xxviii + 490. (London: Macmillan and Co., Ltd., 1920.) Price 10*s.* net.

THIS well-known and authoritative work on cotton spinning is published in three volumes. It deals with all the processes up to carding; with all appliances up to the end of the fly frame; and, finally, with the theory and processes of spinning and with mill planning, including the important subject of humidity. It has reached, in vol. i., a sixth edition, and in vols. ii. and iii. a fifth, which facts sufficiently mark the popularity and authority of the treatise. Vol. iii. has just been re-issued with important additions. The three volumes include no fewer than 543 detailed drawings descriptive of the sources and characteristics of the cotton fibre and of its treatment by means of the machinery through which it passes until it emerges as marketable yarn. They thus form a complete compendium of the several stages of manufacture of this important textile.

Vol. iii. deals especially with the treatment of the fibre necessary to ensure uniformity in the yarn and regularity of diameter and of length, weight, and strength so vitally essential to the production of a round, solid thread. Useful tables of information are given relative to the indicated horse-power required for the various machines, etc. Much new matter is to be found in Appendix ii., relating to gassing, costing, etc., and a detailed index adds considerably to the value of the volume.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relativity.

THE relativist position is stated as being "that only relative motions are of physical importance."

If this is meant to apply to rotation as well as to motions of translation, and to deny that rotation is absolute, and independent of the relation of the revolving body to anything outside itself, I would suggest that a relativist should try the following experiment. Let two casks, A and B, of suitable sizes, be placed one within the other (A inside), and so mounted that either can be rotated independently. Now let the believer in relativity place himself inside A so that he can see nothing but its inner surface. So far as appearances are concerned, he will not know whether A is stationary or in motion.

First let A be stationary and let B be made to revolve at, say, 1000 revs. per minute. This will cause no change of any sort in the sensations of the occupant. Next, with B stationary, let A be given the same angular velocity for a minute or two. If the experimenter survives this trial, he will be in a position to assert that the "physical importance" of the angular velocity of A with reference to B is not the same as that of B with reference to A. So far, however, as the geometrical relations of A and B are concerned, it is a matter of indifference which of the two is revolving.

A. MALLOCK.

9 Baring Crescent, Exeter.

Toads and Red-hot Charcoal.

TOADS are associated with some wonderful myths, and my scepticism was naturally great when my friend Mr. H. Martin Leake assured me, while on a visit to Cawnpore in October of 1915, that toads would eat red-hot charcoal. An after-dinner demonstration, however, soon dispelled my doubts. Small fragments of charcoal heated to a glowing red were thrown on the cement floor in front of several of the small toads (usually *Bufo stomaticus*) which so commonly invade bungalows at that time of year, and, to my surprise, the glowing fragments were eagerly snapped up and swallowed. The toads appeared to suffer no inconvenience, since not only did they not exhibit any signs of discomfort, but, on the contrary, several toads swallowed two or even three fragments in succession. A probable explanation of the picking-up is that the toads mistook the luminous pieces of charcoal for glow-worms or fireflies, the latter being numerous in the grounds of the Agricultural College at Cawnpore in October; but this does not account for the swallowing of the hot particles—the absence of any attempt to disgorge. I repeated the experiment at Allahabad in August, 1916, with the same results (the toads even attempting to pick up glowing cigarette-ends), though I have never observed glow-worms or fireflies in Allahabad at any time of year.

The fact that some toads seized several hot particles in succession would seem to imply either that the heat was not felt (which seems incredible), or that memory is entirely absent in toads; but since toads most certainly come to associate a given time of day with the supply of food, *i.e.* remember, this latter explanation seems to be equally incredible. The truth must be that the incentive to seize an object (a luminous point in this instance) usually associated with an insect is so strong that even acute pain is no deterrent when the experience is limited—the lessons of experience out of the ordinary require to be "burned" into the toad intelligence by sheer repetition, just as the imprisoned shark which repeatedly bruises its snout against the glass of its tank has the lesson "knocked" into it in time. I may add that I unfortunately neglected to examine the toads post-mortem, and that I have recently repeated these experiments with *Bufo vulgaris* in England with entirely negative results.

W. N. F. WOODLAND.

"Kismet," Lock Mead, Maidenhead.

Active Hydrogen.

IN March last I observed an interesting phenomenon while conducting certain experiments, in the Maharajah's College, Vizianagaram, with detonating mixtures with excess of hydrogen when they are subjected to the silent electric discharge in an ozoniser. In one experiment the oxy-hydrogen mixture, after leaving the ozoniser, was allowed to pass through an alkaline solution of potassium permanganate. In the course of the experiment an electric spark accidentally took place in the mixture, and as a consequence an explosion occurred in which a part of my apparatus was smashed to pieces; but to my surprise I found that the whole of my permanganate solution turned green at once.

It was surmised from this that the instantaneous reduction might be due to the presence of an active modification of hydrogen produced in the circumstances, since molecular hydrogen brings about the same change very slowly. In order to study the problem more conveniently, I filled a Hofmann eudiometer with an alkaline solution of potassium permanganate, and a few cubic centimetres of an explosive mixture with excess of hydrogen (3 vols. of hydrogen and 1 vol. of oxygen) were admitted into the explosion tube and the mixture was sparked; as soon as the spark passed through the solution it turned green.

With the object of testing further the reducing efficiency of this new form of activated hydrogen, its effect was examined in a number of reactions. It was thus found that with this hydrogen an alkaline solution of indigo was converted into indigo white, ferric chloride into ferrous chloride, potassium nitrate into potassium nitrite, arsenious acid into arsine, potassium perchlorate into potassium chloride, and a number of other reactions were also tried with like results.

Some references to the literature relating to this subject of active hydrogen may be of interest. In 1913 Sir J. J. Thomson was led to conclude from examination of the paths of positively charged particles that they "revealed the presence of particles having an atomic weight of 3, presumably triatomic molecules of hydrogen." Duane and Wendt showed, in 1917, that when hydrogen is exposed to the bombardment of α-particles from radium emanation a contraction in volume occurs, a fact which has been incidentally observed by Usher, and confirmed recently by Lind. In 1912 Dr. Langmuir discovered an active modification of hydrogen by heating a metallic filament in hydrogen at low pressures. Again, so late as May last, Gerald and Robert S. Landauer published a paper on triatomic hydrogen in the Journal of the American Chemical Society.

These investigators activated hydrogen in different ways, all the methods being dependent on gaseous ionisation. The hydrogen was activated by the α-rays, by the electrical discharge in a vacuum, by the corona, and by Schumann light, though the last means of activating hydrogen was unsuccessful.

Sir J. J. Thomson found in 1913 (Proc. Roy. Soc., A, lxxxix., 20) that "X_3 disappears when a mixture of it with hydrogen is sparked with sufficient oxygen to give a violent explosion." In my experiments, however, I find that the active hydrogen appears with the explosion; moreover, the fact that under similar conditions with excess of oxygen ozone is produced, and with excess of hydrogen an active form of it makes its appearance, is significant when we consider the nature of the chemical process of the formation of water when explosive mixtures are subjected to an electric spark.

Y. VENKATARAMAIAH.

Indian Institute of Science, Bangalore, India, July 23.

The Organisation of University Education.

THE discussion that has been started by the Government's offer of the Bloomsbury site to the University of London has already opened up a bigger question, namely, that of the vital necessity for re-organising thoroughly the university system—or quasi-system—of this country. It is becoming clear that we must have a regional university system, such that every area of sufficient population shall be provided with a fully equipped and fully staffed university as its educational centre and capital; and more and more it is becoming evident that the duties and services of each university will not by any means be exhausted by the teaching and research carried on therein, but that it must undertake besides the tremendously important work of organising tutorial education for the adult workers hungering after knowledge and the work of aiding and leavening and guiding all the secondary schools in its area. If we take account (1) of these considerations and all that they involve in the way of extra-mural organisation and supervision and teaching, (2) of the demand that the Imperial College of Science shall be elevated to university rank, (3) of the objection raised to the Bloomsbury site that ten times its acreage would be required for a university, and (4) of the recent plea that universities should be decentralised and located in the open so far as possible rather than in a city; it seems to follow that very probably the existing University of London will have to be divided into, or replaced by, some half a dozen or so independent universities, one or two central—as, *e.g.*, in Gower Street, etc., and Kensington—and the others in the outer ring to serve the large populations of the Kent and Surrey and Essex and Middlesex areas; and, if this necessity be made clear, no sentimental attachment to the old University of London ought to weigh against the unquestioned needs of education. Of course, millions would be required from the Government to carry out such a scheme; but perhaps one day we may have a Government that, instead of wasting many tens of millions on wild-cat military expeditions, will invest one or two tens in universities—to the incalculable gain of the country.

It seems to me, however, that, if the universities themselves admit the need for regional division and systematic organisation, they should at least pave the way therefor by such working agreements as will utilise to the best advantage so much regional distribution as at present exists instead of perpetuating a sort of chaos. I have been led to these reflections by a study of the pass-lists of the recent London matriculation, from which I see that nearly 3800 candidates entered. (Incidentally, the fact that under 33 per cent. passed suggests certain very serious criticisms, into which, however, I will not digress.) Now, obviously, we have evidence here of a very serious congestion; and it is clear that the congestion might be very considerably lessened if the regional system were applied at once, as a start, to matriculation candidates. I find that among the first 176 successful candidates there are scholars from (1) Beverley, Chesterfield, Halifax, Huddersfield, Keighley, Leeds, Spalding, and Sunderland; (2) Manchester; (3) Birmingham and Worcester; (4) Cardiff, Merthyr Tydvil, Pontypridd, and Swansea; and (5) Bath, *Bideford, Bridgwater, Clifton, Cheltenham, *Exeter, Sherborne, *St. Austell, and Taunton; and this list is not exhaustive, although it includes most of the names specially relevant to my immediate argument. Now it will be evident at once that candidates from all these places have *deregionalised* themselves, since they belong geographically (1) to the University of Leeds or Sheffield; (2) to the University of Manchester; (3) to the University of Birmingham; (4) to the University of Wales; and (5) to the University of Bristol; and it must be added that, if the proposed South-Western University should come into being, candidates from towns marked * would no longer be in the Bristol region.

Now much of this geographical confusion is already gratuitous, since systematisation has already gone thus far that various matriculations (including the Cambridge Previous and Oxford Responsions) are accepted, with varying qualifications and conditions, by various other universities as exempting from their own matriculations; so that already to a considerable extent a student may matriculate at his own regional university and then proceed to his degree in any one of many other universities; but the reciprocity and interchangeability are not even conditionally complete. It is true that in one important communication with which I have been favoured it is stated that "by the introduction in 1918 of school-leaving certificates *all entrance tests were pooled*"; but on inquiry and examination of the matriculation regulations of the various universities I find that this comforting statement is, unhappily, too sweeping. I will instance the most important exception. One of the newer universities—which is unique in having taken an entirely independent line and in making very practical recognition of the great educational fact (largely ignored by all other universities) that unchangeable inborn aptitudes vary very greatly, and that brains of equal quantitative value have profound qualitative differences—deviates from all the other universities in its matriculation requirements in that, first, and of least importance, it does not limit a candidate to five or six subjects, but merely stipulates for a minimum of two each in two groups and one in a third; secondly, it makes *no subject compulsory*; and, thirdly, it "passes" or "ploughs" by groups apparently instead of by individual subjects, with the very proper proviso that below a certain minimum no marks in any subject shall count towards its group-marks.

Now this scheme involves, to my thinking, an educational advance of tremendous significance, since it recognises the inborn qualitative differences and proclivities of boys' and girls' brains, and refuses to insist that round and square and hexagonal and triangular minds shall all be required to fit into one Procrustean or Chinese examination-gauge; but the apparent difficulty or impossibility of reconciling the requirements of this independent university with those of its far more tradition-bound fellows is obvious; and unless the difficulty can be overcome, either the regional system for matriculation must be abandoned, or those who matriculate at this university will find that they cannot proceed to a degree in various other universities as matriculated students.

Three courses are open:—First, all universities might adopt similar reformed regulations; but this suggestion may be dismissed as a counsel of perfection outside the range of present practical politics. Secondly, this innovating university might abandon its reformed ways and drop into line with subject-marks, instead of group-marks, and several compulsory subjects; but this, to my mind, would be educationally calamitous. Free, untrammelled experiment, spontaneity, and autonomy are essential to educational life and progress, whereas cast-iron uniformity and the repression of individuality in universities and schools are deadly and should be utter anathema. The third course obviates all difficulties. Let each university make its own regulations for its own matriculation, but let it regionally examine students in such wise as to grant the greatest latitude allowed by the most elastic scheme, and issue certificates qualifying for matriculation either in its own domain, or both therein and at various other universities, or at only certain universities, or at only one. Every university in the kingdom could then regionally matriculate students for every other, subject to such regulations as these: "Unless you pass in subjects *x* and *y* you cannot proceed to universities A, B, C, D; unless you pass in *x* and *y* and *z* you cannot proceed to E and F; unless you pass in *w* and *x* you cannot proceed to G," and so on.

When the pass conformed with the requirements of the examining university a certificate of matriculation at that university would be issued; when otherwise, a certificate entitling the student to matriculate at the universities specified therein. This suggestion assumes, of course, both that the papers set by each university in any subject reach the same standard, and that the percentages of marks qualifying for a pass are the same; and I believe that approximately such uniformity in England has already been obtained, except that the Previous and Responsions are apparently easier than the matriculation examinations of the other universities, although, with qualifications and conditions, they are, curiously enough, accepted by these.

Subject, then, to such very practicable working arrangements, and in view of the extent to which co-ordination already obtains, surely the universities should take another step forward and agree to delimit their respective areas and to refuse candidates for matriculation from another "region," and similarly, of course, to refuse to undertake tutorial classes for adults and extension-lectures in another region. As things are at present, London figures as a sort of poacher on the preserves of all its neighbours, since it holds its matriculation examinations at provincial centres all over the country, and sweeps into its net the natural matriculation prey of its sister (or daughter) universities—at the cost of the shocking congestion already described. Here clearly we find pre-regional practices surviving anachronistically in regional times. The explanation is that (1) originally there were no provincial universities, and therefore London most properly consulted the convenience of provincial students; and (2) the London matriculation long since attained a *kudos* that does not attach in the lay mind to the matriculations of the newer universities. The trouble, I suspect, lies not so much with those who intend to proceed to their degrees—since so many of the matriculations will secure their entrance to any of the universities, and the Final degree eclipses utterly any matriculation *kudos*—as with the large number who intend to go no farther, but desire the matriculation certificate as a proof that they have reached a certain standard of school education. Now, however, all these matriculations have been approximately standardised with the precise object of rendering these "First School certificates" equivalent; and all that is necessary in order to bring the lay public up to date is that the universities should proclaim this fact by delimiting their regions and refusing extra-regional matriculation candidates.

I anticipate no agreement with my views, but only contemptuous contradiction, from those who think in traditional grooves and have not realised the difference between 1920 and 1890 or 1860; but I submit that universities must play a vastly larger part in national life henceforward than in the past, must lead and direct and inspire education and research of all sorts and all grades, and must function as the pulsating heart and controlling brain, each of its own region; that their extra-mural activities in several directions must be enormously increased; and that only by covering the country with a network of regional universities, each responsible for its own region, can we enable each fully to develop its functions of guiding and inspiring secondary education and adult education and research *of all sorts* in its region.

I most specifically confine my proposals for regional distribution of candidates to the matriculation examination, not only because it will frequently happen that after schooldays a change of residence will bring the undergraduate into another region, but also because it has rightly been urged that each university, besides covering the general courses, should aim at making some one "school" a specialty, and that education would be hindered rather than helped, and energy dissipated, if every university sought to collect a few students in each of several uncommon subjects—*e.g.* tropical medicine or palæobotany—instead of bidding all the comparatively few students of each such subject betake themselves to whichever university may have been led to establish a special school or department for the study thereof; and because, as I have said, free experiment and varied curricula are eminently to be desired—given, of course, that all standards should be approximately equal in the sense that a given degree should always imply equivalent brains and equivalent training, and that educationally cheap and nasty degrees should be unknown—and every matriculated student from whatever part of the country should be free to enter whatever university best fitted his own inborn proclivities and mental bent.

In fine, I suggest that *divide et impera* must be the motto of the universities if education in its very widest sense is to hold true imperial sway.

FRANK H. PERRYCOSTE.

Higher Shute Cottage, Polperro, R.S.O., Cornwall, August 20.

Portraits of Myriapodologists.

YOUR correspondent, Mr. S. Graham Brade-Birks (NATURE, September 2, p. 9), will find a portrait of George Shaw in Thornton's "New Illustrations of the Sexual System of Linnæus," and a photo-portrait of J. E. Gray in "Portraits of Men of Eminence" (1863). Also large engraved portraits by Maguire of J. E. Gray (1851) and John Curtis (1850), both in the collection of the General Library of the British Museum (Natural History). B. B. WOODWARD.

4 Longfield Road, Ealing, W.5, September 3.

Age and Growth Determination in Fishes.

By ROSA M. LEE.

FOR centuries past it has been known that the scales of fishes showed concentric rings, and later observers have concluded that from the number of these rings the age of the fish could be ascertained.

This discovery was, however, not developed to any great extent until the last ten or twenty years, during which several scientific observers definitely traced the connection between the number of rings on the scales and the number of years of life of certain fishes, the carp amongst freshwater fishes and certain Gadidæ amongst saltwater fishes having been intensively examined and providing a first proof of the correctness of the general theory. The salmon is another fish the economic value and the intrinsic interest of which led to particular attention being paid to its scales in connection with its life-history by many observers, both of professional and amateur status.

But it was the activities of the International Council for the Exploration of the Sea that gave the greatest impetus to the investigation of the age of fishes, and most systematic researches have been carried out with the purpose of correlating the knowledge gained from scale investigations as to the life-history of fishes with that derived from other methods of investigation undertaken by the Council. Amongst the workers of all the nations who have investigated this subject, the Norwegians stand pre-eminent for the very exhaustive researches they have carried on and for the original developments they have made in the methods used, both practical and theoretical. They have concentrated largely on investigating this question in the herring and salmon races, and their contributions to the knowledge of the age distribution and growth of these species have been very valuable.

A great deal of work on the same lines has been carried on by the other countries (including Great Britain) participating in the work of the Council, not only in Europe, but also in America, and the data now collected in regard to various species are extensive enough to enable us to judge the validity of the methods used and the importance of the results obtained.

The theory of age determination, briefly enunciated, is that the periodic quickening and slackening of growth in the fish brought about by the annual changes in the external conditions of their life, viz. summer and winter temperatures, with their accompanying abundance and scarcity of food, or of appetite for food, are reflected in the formation of the scales, and are mainly evident as rings marking the winter growth when development of the scale either slackens or wholly ceases. Such rings can be seen easily with the naked eye or with a low-power lens on the scales of many fishes, and those on the salmon scale illustrated in Fig. 1 furnish an example of the general appearance of winter rings.

Such rings are caused by the definite patterns into which the lines on the upper surface of the scale are formed under changing conditions. The arrangement varies for every species of fish, those of the same family being somewhat alike. Indeed, fish can be identified by their scales alone, as has been done on tinned fish purporting to be salmon.

There are striking differences in the appearance of the winter rings in the scales of certain well-known fishes. In the herring scale the striæ (surface lines) are close and equidistant; they pass from side to side, and appear to be broken by narrow, concentric, transparent rings. In the haddock there are small quadrilaterals arranged concentrically, occurring in zones of wide and narrow growth. In the smelt and the eel this state of wide and narrow zones can be traced, but only with difficulty, and the winter growth is indicated by clear concentric spaces, where the markings are either incomplete or wholly absent. In certain river fish also the winter growth can be traced by the unfinished lines rather than by the narrowing or closing in of the lines, which often marks winter growth.

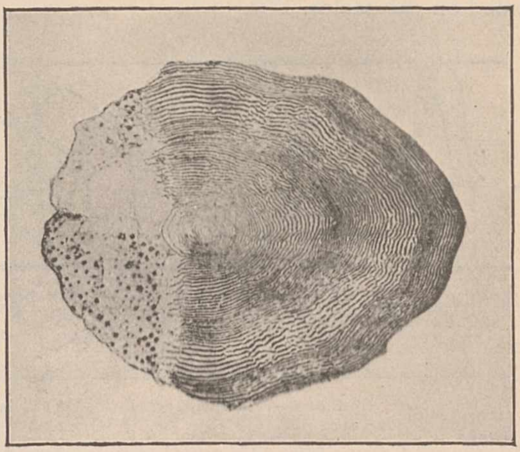

FIG. 1.—Winter rings on a salmon scale.

Underlying all the differences in the patterns on the scales of the various fish a common principle of formation can be traced, and this is undoubtedly due (in normal circumstances) to the annual slackening or cessation of growth associated with winter conditions.

A study of many scales at all times of the year has shown that the discontinuity or incompleteness of the markings (striæ or platelets) may be a temporary characteristic of nearly all stages of growth, and that when growth is active (summer growth) the lines ultimately become complete, but that in the winter they remain incomplete, and therefore the discontinuity serves to mark out the winter growth, because the discontinuity becomes permanent, and leaves on the scales the blank spaces or broken lines which are the characteristic winter rings of certain species in addition to the narrowing of the spaces between the lines.

By counting the rings formed on the scale, the age of any individual fish can be ascertained. When large numbers of any one species are examined they can be grouped into "age classes" or "year groups" according to the number of rings. The average size of each group can be determined, and the difference between these sizes gives the first approximation to the amount of annual growth.

This general theory has been confirmed for several species, first by an examination of the growing edge of the scale throughout the season, when the rings have been seen in the course of development, and secondly by marking experiments on the fish (salmon, plaice, cod, etc.), when additional rings corresponding in number to the winters elapsed in the interval between marking and recapture have in every case been seen to be formed on the scales.

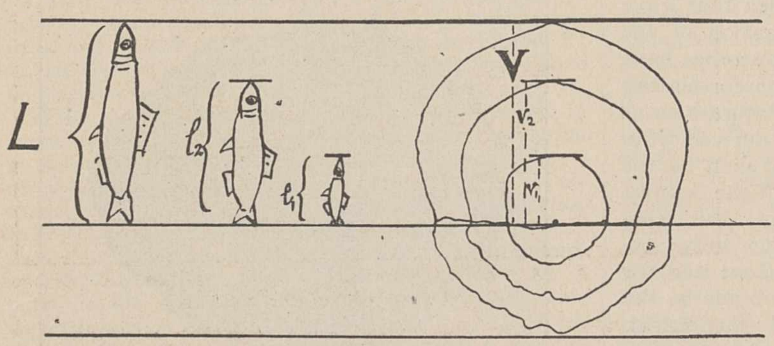

FIG. 2.—Proportional growth of a fish and its scale.

In practice there are, however, certain modifications and exceptions to the general theory which must be looked for and taken into account. What are known as "false rings" may occur. These bear a resemblance to winter rings, and are probably caused by sudden changes in environment, such as a change of temperature, lack or abundance of food, or even by the fish migrating from one part of the sea to another. These rings can generally be distinguished from true rings in the scales of fishes the habits of which are known. For instance, in salmon there is frequently a grouping of close lines in the middle of the third summer, known as a "summer check."

In very old fish the rings are close together near the edge, and it is difficult to make out their number with exactitude. It may sometimes happen that the latest rings become fused together, and the total number then appears less than those shown on the bony and opercular structures of the same fish.

Results of age determinations of many samples of fish have been studied from the mathematical probability point of view to ascertain whether such groups have a probable or natural variation of size, and whether groups of fish of the same ascertained number of rings taken under similar conditions are sufficiently alike in size grouping to give a high probability of being of the same age. These mathematical tests have confirmed the theory that on the average the age determinations of certain species of fish (salmon and herring) are correct up to five or six years of life—that is, those years when they are of most economic importance.

These methods of age determination enabled observers to deduce the approximate growth rates of fish by comparing the sizes of fish of known age. Growth curves so deduced generally rose rapidly from zero for the first two or three years of life, and then the rate of increase fell off rapidly as the fish grew older.

Later researches have demonstrated that this falling off in the growth rate in such fish as herring and plaice and others is not wholly due to a normal slackening in the development, but is made greater by the fact that in several species a segregation according to size takes place, the larger fish of the youngest groups leaving their associates and joining shoals of older fish, generally in deeper water. Such a segregation has been found to take place at the onset of maturity in certain species. Thus it follows that the youngest year groups in the samples are represented only by the larger individuals of those groups, and their average length is higher than those of the complete year group.

When such selection of size occurs, the average sizes of successive age groups are not strictly comparable with one another.

Norwegian investigators developed the method of ascertaining the growth of individual fish by measuring the comparative distances between the rings on the scales, on the assumption that the scale grows in length in proportion to the length of the fish. Fig. 2 shows a fish of length L with an enlarged image of its scale. The scale is measured from its centre along the main axis, and also to the edge of the winter rings, giving the values V (length of scale), v_1, v_2, etc. (lengths from centre to end of first, second winter rings, etc.). If exact proportional growth is assumed between the fish and its scale, it is evident from the parallel lines in the diagram that $l_1 : v_1 :: L : V$, and the lengths at previous winters (l_1, l_2, etc.) are found from the simple formulæ

$$l_1 = \frac{v_1}{V} \cdot L, \quad l_2 = \frac{v_2}{V} \cdot L, \text{ etc.}$$

Such a method enables the data as to growth to be multiplied to a very great extent, and should therefore be most valuable in detecting good and bad years of growth, which can be associated with known physical conditions, with the onset of maturity or even with migrations into different waters, and as such they have enormous value.

But, after studying the results obtained, certain investigators have doubted the validity of this method of ascertaining growth. It was noticed that in all species so investigated the calculated lengths for the first and succeeding winters became successively less and less as they were found from older and older fish, and other apparent discrepancies were pointed out by different observers. As a matter of fact, the above method gives only a first approximation to the actual lengths to which the fish grows at the end of each winter of life. It is based on the assumption that the lengths of the scale are themselves proportional to the length of the fish—a closer approximation (but still an approximation), for the calculation is given by taking the increments of growth of the scale as proportional to the increments of growth of the fish, starting from the point at which the scale first appears, which is in most cases an amount sufficiently appreciable to affect the calculations of the first two or three winter lengths considerably.

In Fig. 3 the average relations in the observed lengths of the scale and the corresponding fish, and in the observed lengths of the fish and the corresponding scales, are shown by the dots and crosses respectively.

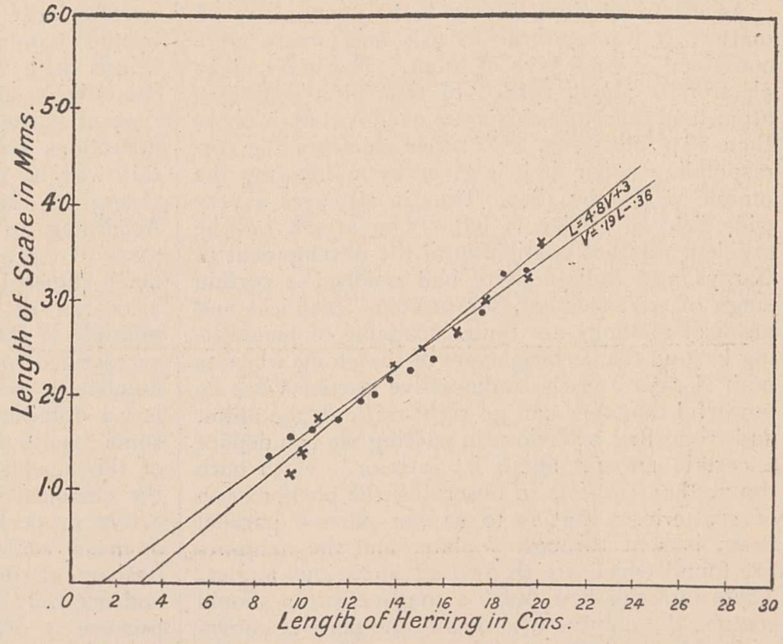

FIG. 3.—Showing average relations between measurements of fish and their scales.

A mathematical relation can be found by combining all the corresponding measures of scales and fish. This is known as a correlation coefficient, and in the case depicted was very high, viz. $r=0{\cdot}95$. The points lie very nearly on straight lines, known as "regression lines," the mathematical equations to which are $L=4{\cdot}8V+3$ and $V=0{\cdot}19L-0{\cdot}36$. From the first of these equations the length of the fish can be calculated when the length of the scale is known from measurements.

The general form of this equation for any series of measurements of fish and their scales is $L=aV+c$, the constant term c corresponding to the length at which the scale begins to grow. In the case of North Sea herring c is about 3 cm.

As in practice only relative lengths of the winter rings are measured on the scale, the constant a in the equation can be eliminated, and the calculated lengths to any previous winter (L_1, L_2, etc.) derived from the equation put in the form

$$L_1=c+\frac{v_1}{V}(L-c), \text{ etc.}$$

The results obtained by the use of this formula approximate more closely to values derived from observation than in the case of the original formula when c is not taken into account, and the growth measures calculated in this way can therefore be assumed to be a closer approximation to the truth.

In all cases of age and growth determination individual records may be wrong, owing to one or other of many difficulties that may occur in deciphering the scale, but the latest work on the subject has shown that *average* values, both of age distribution in a sample and of amount of growth, are approximately correct.

The Structure of the Atom.

By C. G. DARWIN.

I.—*Atomic Number.*

THE study of the interior structure of the atom was initiated about twenty-five years ago by J. J. Thomson's discovery of the electron. Electrons are particles of negative electricity of charge $4{\cdot}77\times10^{-10}$ electrostatic units and mass $9{\cdot}0\times10^{-28}$ gr., and they were shown to be constituents of every type of matter. Some years previously Thomson had shown on theoretical grounds that any charged body should possess extra mass on account of its charge, and these two facts taken together suggested the possibility of an electrical theory of matter, whereby all mass should be electromagnetic in origin, and all the properties of matter should be reproduced by the interactions of electrons and positive charges, the latter at that time quite unknown. It is not possible to dwell here on the earlier atom models (such as those of Thomson or Ritz) which were devised on these lines. They had a certain measure of success in explaining some of the properties of matter; but we can now see that there was insufficient experimental knowledge at that time, and also that no theory could possibly work which was based on the old classical ideas of dynamics, as these are certainly inadequate to deal with atomic problems.

As electrons were known to be common to all matter, it was natural to ask how many were contained in each type of atom. The mass of an electron is about 1/1840 of that of a hydrogen atom, and therefore this atom cannot contain more than 1840 electrons. For other elements the corresponding upper limit is given by multiplying the atomic weight by 1840. Thus in all cases a very wide field of choice is left. The attack on the problem was not possible until the development of X-rays and radio-activity had reached a certain stage of advancement, for ordinary chemical and physical methods are quite incapable of penetrating beyond the surface layers of the atom, whereas both X-rays and the radio-active particles are so powerful that they can go right through the atom, and from their behaviour in passing we can deduce a certain amount about its interior. With both the method consists in observing the phenomenon of scattering; that is to say, a narrow parallel beam is sent through a plate, and the amounts are found which are thrown off at various angles. Theory tells us how much a single electron should scatter, the number of atoms in the plate is known with some accuracy, and so we can count the number of electrons in each atom, if we assume that the scattering is due to them alone. When this method is applied with either X-rays or β-particles (the latter are simply electrons moving at a high speed), certain theoretical complications make the results rather inaccurate, but in both cases the experiments clearly indicated that the number of electrons in the atom was of the same general magnitude as the atomic weight. This was found for several elements ranging in weight between carbon and gold. So our first upper limit to the number of electrons in the atom was vastly in excess, and no considerable fraction of the mass of an atom is contributed by its electrons.

The experiments with α-particles were far more definite. An α-particle is simply a helium atom, carrying a positive charge equal to that of two electrons, and moving at a very high speed. As the atomic weight of helium is 4, it is seven thousand times as heavy as an electron. When an α-particle passes an electron the attractive force sets the electron in motion, and the reaction of this force gives the α-particle a small deflection and reduces its velocity slightly. On account of the smallness of the effect of a single electron, great uniformity is obtained in the average, and the number of electrons in an atom can be counted by observing either the scattering of the beam or else the rate at which the particles lose their velocity. Both give the same result, that the number of electrons in an atom is approximately half its atomic weight.

But the experiments on the scattering of α-particles contained the germ of far more important information. For in the course of them it was observed that a certain small fraction of the α-particles underwent large deflections. A few even were thrown right backwards. Now this fraction, though small in itself, was out of all proportion large compared with what could be given by the cumulative effect of a large number of collisions with electrons. Rutherford showed that the only reasonable hypothesis to account for this type of scattering was to suppose that the large deflections were produced in a single step. In this way he was led to put forward the nucleus theory of the atom, now universally accepted. According to this theory practically the whole mass of the atom is carried by a nucleus of very small dimensions (at most 10^{-12} cm.) which has a charge of positive electricity equal to some multiple of the electronic charge. This nucleus is surrounded by a cloud of electrons of just such a number as to neutralise its charge. Each element has a different nuclear charge, and (to anticipate some results that we shall come to later) the value of this nuclear charge completely determines all the chemical characters of the element. Radio-active properties belong to the nucleus, as well as mass, while chemical and spectroscopic properties are attributed to the electrons of the cloud, and are only indirectly controlled by the nucleus because it determines the number and arrangement of these surrounding electrons. The dynamical structure of this planetary system was left unspecified, and remains to this day almost unknown.

Now consider the bearing of this theory on the question of scattering. The α-particle is itself the nucleus of a helium atom. In passing through matter most of the particles will not go very near any nucleus, and so will behave in the way we have already discussed. But the paths of a few will take them near some nucleus, and large repulsive forces will be developed between the two positive charges. Most atoms are much heavier than α-particles, and so the latter will describe hyperbolas according to Newton's laws, and pass off in new directions. It is a simple matter to calculate the number of particles to be expected at any inclination to the original beam in terms of their initial velocity and the charge on the nucleus. The comparison with experiment, therefore, first furnishes a test as to whether the law of force has been taken correctly, and then provides a value for the nuclear charge. In both particulars the experiments fully bore out the prediction, and it was found that the nuclear charge (measured with the electronic charge as unit) was about half the atomic weight for the lighter elements, and rather less than half for the heavier.

Table of Atomic Numbers of the Elements.

	Hydrogen **1.** H, 1·008 1·008									
Helium **2.** He, 4·00 4	Lithium **3.** Li, 6·94	Beryllium **4.** Be, 9·1	Boron **5.** B, 10·9 10, 11	Carbon **6.** C, 12·00 12	Nitrogen **7.** N, 14·01 14	Oxygen **8.** O, 16·00 16	Fluorine **9.** F, 19·00 19			
Neon **10.** Ne, 20·2 20, 22	Sodium **11.** Na, 23·00	Magnesium **12.** Mg, 24·32	Aluminium **13.** Al, 27·1	Silicon **14.** Si, 28·3 28, 29	Phosphorus **15.** P, 31·04 31	Sulphur **16.** S, 32·06 32	Chlorine **17.** Cl, 35·46 35, 37			
Argon **18.** A, 39·88 36, 40	Potassium **19.** K, 39·1 Copper **29.** Cu, 63·57	Calcium **20.** Ca, 40·07 Zinc **30.** Zn, 65·37	Scandium **21.** Sc, 44·1 Gallium **31.** Ga, 69·9	Titanium **22.** Ti, 48·1 Germanium **32.** Ge, 72·5	Vanadium **23.** V, 51·06 Arsenic **33.** As, 74·96 75	Chromium **24.** Cr, 52·0 Selenium **34.** Se, 79·2	Manganese **25.** Mn, 54·93 Bromine **35.** Br, 79·92 79, 81	Iron **26.** Fe, 55·85	Cobalt **27.** Co, 58·97	Nickel **28.** Ni, 58·68
Krypton **36.** Kr, 82·92 78, 80, 82, 83, 84, 86	Rubidium **37.** Rb, 85·45 Silver **47.** Ag, 107·88	Strontium **38.** Sr, 87·83 Cadmium **48.** Cd, 112·4	Yttrium **39.** Y, 88·7 Indium **49.** In, 114·8	Zirconium **40.** Zr, 90·6 Tin **50.** Sn, 118·7	Niobium **41.** Nb, 93·5 Antimony **51.** Sb, 120·2	Molybdenum **42.** Mo, 96·0 Tellurium **52.** Te, 127·5	— **43.** Iodine **53.** I, 126·92	Ruthenium **44.** Ru, 101·7	Rhodium **45.** Rh, 102·9	Palladium **46.** Pd, 106·7
Xenon **54.** Xe, 130·2 128, 130–1–3–5	Cæsium **55.** Cs, 132·81 Samarium **62.** Sa, 150·4 Thulium **69.** Tu, 168·5 Gold **79.** Au, 197·2	Barium **56.** Ba, 137·37 Europium **63.** Eu, 152·0 Ytterbium **70.** Yb, 173·5 Mercury **80.** Hg, 200·6 197–204	Lanthanum **57.** La, 139·0 Gadolinium **64.** Gd, 157·3 Lutecium **71.** Lu, 175 Thallium **81.** Tl, 204·0 IV.	Cerium **58.** Ce, 140·25 Terbium **65.** Tb, 159·2 Keltium **72.** Kt Lead **82.** Pb, 207·2 XI.	Praseodymium **59.** Pr, 140·6 Dysprosium **66.** Ds, 162·5 Tantalum **73.** Ta, 181·5 Bismuth **83.** W, 208·0 V.	Neodymium **60.** Nd, 144·3 Holmium **67.** Ho, 163·5 Tungsten **74.** W, 184·0 Polonium **84.** VII.	— **61.** Erbium **68.** Er, 167·7 — **75.** — **85.**	Osmium **76.** Os, 190·9	Iridium **77.** Ir, 193·1	Platinum **78.** Pt, 195·2
Emanation **86.** III.	— **87.**	Radium **88.** Ra, 226·0 IV.	Actinium **89.** Ac II.	Thorium **90.** Th, 232·15 VI.	U.X$_{II}$ **91.** II.	Uranium **92.** U, 238·2 II.				

The atomic numbers were mostly fixed by the less direct method of Moseley, which are given in the table. Thus, as an example, read:—Chlorine, atomic number **17,** symbol Cl, atomic weight by chemical methods 35·46, composed of two isotopes 35 and 37. In the case of the radio-elements (**81–92**) the evidence is of a different kind, and the roman numeral gives the number of them believed to exist. The nomenclature of some of the rare earths (**69–72**) is not yet standardised. The names here are those used by Moseley. Some of these elements, though detected by their X-ray spectra, have never been isolated. As points of some interest, observe that in three cases (A and K, Co and Ni, Te and I) the order of atomic weights is wrong, while the periodicity of the chemical properties corresponds to the atomic number. Observe also the five missing elements—**43, 61, 75, 85, 87;** the properties of which can be predicted with fair confidence from the Periodic Law. A curious relation, pointed out by Rydberg, is that the atomic numbers of all the inert gases are given by taking the series $2(1^2+2^2+2^2+3^2+3^2+4^2+\ldots)$ and stopping the summation at any term.

will be described later. For convenience the "isotopes" (also to be discussed later)

This method of determining the number of electrons in the atom is by far the most direct yet devised, as the interpretation of the experiments does not involve the rather difficult averaging necessary for the compound scattering produced by the electrons.

Now if we make a table of all the elements arranged in order of atomic weights, as is done by chemists for the study of the Periodic Law, and if we number them in this order, starting with hydrogen at 1, helium at 2, and so on, as on p. 53, it will be seen that the resulting numbers are always in the neighbourhood of half the atomic weight. The nuclear charge is by hypothesis some multiple of the electronic charge, and by experiment is about half the atomic weight, and so we are almost forced to suppose that the ordinal number of an element in the table is the same as the number of electronic charges on its nucleus. We do not anticipate an exact correspondence throughout the table, because there may be (and in fact are) gaps in it which represent hitherto undiscovered elements. But apart from this we arrive at the conception of an *atomic number* for each element. The atomic number of an element is defined as the number of positive electronic charges carried by its nucleus, or, which is the same thing, as the number of electrons surrounding this nucleus.

(*To be continued.*)

Obituary.

CANON C. H. W. JOHNS.

BY the death of the Rev. C. H. W. Johns, Master of St. Catharine's College, Cambridge, and Canon of Norwich, Assyriology has lost another of its most prominent representatives in this country. It was almost exactly a year after the death of Prof. L. W. King that Canon Johns passed away. He had been noted as an Assyrian scholar for many years past; held the post of lecturer in Assyrian at his college of Queens', in the University of Cambridge, for fourteen years; and preceded Prof. King as Assyrian reader at King's College, London. These lectureships he vacated on his appointment as Master of St. Catharine's in 1909. The duties of the head of a college in no way interfered with the continued prosecution of his Assyrian studies, and to the last Dr. Johns was at work on the cuneiform inscriptions to which he had devoted a large part of his life. He was an excellent decipherer of the tablets, and had had much experience as a student of Ashurbanipal's library in the British Museum, to the officials of which, and especially to the late Prof. King, he was always *persona grata* and a valued colleague in science. His most notable publication is probably his "Assyrian Deeds and Documents," published in 1898—a series of copies and translations of a large number of cuneiform legal and other records preserved in the British Museum. He also wrote on the famous legal code of Hammurabi, delivered the Schweich Lectures on the relations between the Laws of Babylonia and the Laws of the Hebrew peoples, and contributed articles on Mesopotamian law and history to various scientific journals and dictionaries, notably to the "Encyclopædia Biblica." His death is a great loss to the scientific study of Mesopotamian archæology.

H. R. HALL.

PROF. ADAM POLITZER, whose death has just been announced from Vienna, was recognised in all lands as the leading specialist of his time in diseases of the ear. He was born in Hungary on October 1, 1835, and, taking his medical degrees at the University of Vienna in 1859, went abroad to study the anatomy and diseases of the ear, coming to London to work at the pathology of the ear under Mr. Joseph Toynbee, F.R.S. Returning to Vienna, he quickly established himself as the leading exponent of the newest learning concerning the organ of hearing and its defects, and his growing fame drew medical men to Vienna from all parts of the civilised world. The secret of his success was that he founded his methods of treatment on a first-hand knowledge of the structure, action, and pathology of all parts of the ear. He sought to give to the practice of the aural surgeon a foundation on fact, and not the least of his discoveries were made in the fields of normal anatomy.

THE death of SIR CHARLES LYALL leaves a gap in the ranks of the older school of Orientalists, in which field he will be remembered rather than as an eminent Indian administrator. Sir Charles became a member of the Civil Service in the United Provinces of Agra and Oudh in 1867, and, without much experience of district work, he was absorbed in the Provincial Secretariat, and then went to Simla and Calcutta. Much of his service was passed in Assam, of which province he became Chief Commissioner. Transferred to the Central Provinces, his training in administration failed to prepare him for the emergency of the great famine of 1897, and he was removed to the India Office as Secretary of the Judicial and Public Department. Here he was able to resume his work on Indian languages, particularly Hindustani, and he showed his profound knowledge of Arabic by numerous translations of its poetic literature, which he discussed in successive editions of the "Encyclopædia Britannica." Sir Charles Lyall was a tower of strength to the Royal Asiatic Society, of which he was vice-president, working with Orientalists like James Kennedy and Vincent A. Smith, both of whom recently died. His services to literature were rewarded by several honorary degrees, and by the coveted distinction of fellowship of the British Academy.

Notes.

ON August 31 and September 1 the centenary of the discovery of electromagnetic action by the Danish physicist, Hans Christian Oersted, was celebrated at Copenhagen. Meetings were held in the Town Hall and University, at which many Scandinavian men of science were present, and the occasion was marked by the publication of some of Oersted's scientific correspondence. It was during the winter of 1819–20 that Oersted observed that a wire uniting the ends of a voltaic battery affected a magnet placed in its vicinity, and after prosecuting his inquiries some months longer, in July, 1820, he published his Latin tract, "Experimenta circa effectum Conflictus Electrici in Acum Magneticum." The importance of his discovery received instant recognition. Ampère, Arago, and Davy all seized on the idea, and four months after the publication of his tract Oersted was elected a foreign member of the Royal Society and awarded the Copley medal. Efforts to connect magnetism with electricity had hitherto met with little success, and Wollaston, in his discourse as president of the Royal Society, referring to Oersted's discovery, expressed the hope that "the gleam of light which thus beams upon us may be the dawn of a new day, in which the clouds which have hitherto veiled from our sight the hidden mysteries of light and heat, of electricity and magnetism, may be dispelled." Oersted, who was the son of a country apothecary, originally studied medicine, but turning his attention to chemistry and physics while at Copenhagen University, he was in 1806 appointed to the chair of physics, and he held that position until his death in March, 1851, at the age of seventy-three. Known alike for his genial and kindly nature and for his scientific labours, he was the author of some two hundred memoirs, and received many honours at home and abroad. Twenty-five years after his death a bronze statue of him was erected on the old fortification of Copenhagen.

THE joint committee appointed by the Illuminating Engineering Society to inquire into the subject of eye-strain in kinema theatres has now presented an interim report to the London County Council. The committee consisted of representatives of the Illuminating Engineering Society, the Council of British Ophthalmologists, the Physiological Society, and the kinema industry, and also received the help of various officers of the London County Council. Its main conclusions are concerned with the undue proximity of seats to the screen as a cause of eye-fatigue. The committee expresses the opinion that a high angle of view is one of the most important causes of eye-strain. It is accordingly recommended that the angle between the horizontal plane passing through the observer's eye and the plane containing the observer's eye and the top edge of the picture should not exceed 35°. This is, roughly, equivalent to specifying that the ratio between the distance of the nearest seats from the screen and the height of the top of the picture above eye-level should not be less than 1 : 43. A second recommendation limiting to 25° the obliquity of view from the sides of the theatre is also made. The conclusions are based on actual experience in a number of kinemas in London, and will doubtless be accepted as moderate in scope. Various other matters, such as the origin of flicker, the effect of imperfect films and apparatus, and the conditions of artificial lighting to be provided in halls, are also dealt with, although formal conclusions are not presented at this stage. With proper precautions it appears that the provision of a low general illumination in halls is consistent with a satisfactory image on the screen. Such inquiries, besides being in the public interest, should ultimately also be for the benefit of the kinema industry, and we are glad to note that several representatives of the industry shared in the investigation.

PROF. J. B. FARMER, professor of botany in the Imperial College of Science and Technology, has been appointed by an Order of Council to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

WE learn from *Science* of August 20 that Dr. George Ellery Hale, director of Mount Wilson Observatory, has been elected a foreign member of the Società Italiana delle Scienze, Rome, in succession to the late Lord Rayleigh.

SEVERE earthquake shocks occurred at Milan, and in other parts of Northern and Central Italy, shortly before eight o'clock on September 7. The centre of the disturbance seems to have been in the province of Massa Carrara, where several villages have been much damaged and the small town of Villa Collemandina has been destroyed.

THE next meeting of the Association of Economic Biologists will be held on Friday, September 24, at the Royal Botanic Gardens, Kew. At 2.30 p.m. a discussion will be opened on problems of susceptibility or immunity to disease in plants, the following being the principal speakers:—A. Howard, The Relation of Soil Aeration and Soil Temperature to Disease in Plants; E. S. Salmon, The Relation of Climatic Factors to Disease in Plants; and F. T. Brooks, Immunity to Disease in Plants as a Mendelian Factor.

AT a meeting of delegates appointed by the scientific academies of the Allied nations held in Brussels in July, 1919, an International Research Council was formed for the co-ordination of work and effort in the various branches of science and its applications. Each country, by means of its national academy or national research council or its Government, can take part in the scheme. We gather from an address on the organisation of research delivered before the Association of American Universities by Dr. J. R. Angell, and reproduced in the July number of the *Scientific Monthly*, that the United States has established a National Research Council to deal with the organisation and conduct of research in that country. While in Germany the work was done most effectively by an autocratic Government, it was felt that in a democratic country an enterprise of this type could only meet with conspicuous success if freed from Government control. The funds are provided from the Rockefeller Foundation and other private sources, and arrangements with the universities for the training of research workers, for the organisation of research, and for the supply of information regarding current research have already been made.

THE Nile Projects Commission, appointed to consider the proposals of the Egyptian Ministry of Public Works for improving the regulation of the Nile discharge with the view of extending the cultivable area of Egypt, has issued an interim report, in which, dealing first with the ethical charges brought by Sir William Willcocks and Col. Kennedy against Sir Murdoch Macdonald, the Adviser to the Egyptian Ministry of Public Works, the Commission states that on a careful consideration of all the evidence the members are unanimously of opinion that there has been no falsification or intentional suppression of records or any fraudulent manipulation of data. A study of the projects as described in "Nile Control," the official statement by Sir Murdoch Macdonald, has further led the Commission to the conclusion that, considered strictly from an engineering point of view, the White Nile dam, the Gezireh irrigation scheme and Blue Nile (Sennar) dam, and the Nag Hammadi barrage should be carried out at once. A final report is promised, in which will be considered at length the Commission's observations made in Egypt, the character of the data, the criticisms received and an examination of the evidence given on oath, and other matters. The members of the Commission are Mr. F. St. John Gebbie (president), Prof. H. T. Cory, and Dr. G. C. Simpson.

MR. J. J. JOICEY has acquired for the Hill Museum, Witley, the collection of Lepidoptera formed by Mr. H. J. Elwes, as well as the large collection of Heliconius formed by the late H. Riffarth. The museum has lately also received large collections of Lepidoptera from Central Africa, obtained by Mr. and Mrs. T. A. Barns, who have recently returned from a twelve months' trip undertaken on behalf of Mr. Joicey. Mr. Barns has recorded many interesting observations on the bionomics of the Lepidoptera collected. Some remarkable kinematograph films were taken *en route* of both geographical and entomological interest. A report on the results of this expedition is in progress. The museum has also in preparation papers on the Lepidoptera of Hainan, of the Schouten Islands, of Dutch New Guinea, Misol, Aru, Key, Tenimber, Obi, and Sula Islands, and a report on the Lepidoptera collected by Messrs. Pratt in the mountains of Central Ceram. Mr. Joicey has now sent the three brothers Pratt to Dutch New Guinea. They have reached the mountains in an area south of Geelvinck Bay, entomologically unexplored, and a consignment of specimens has already been dispatched. It is expected that important zoological results will be obtained by this expedition.

IN the Journal of the Royal Anthropological Institute (vol. xlix., July–December, 1919) Mr. S. Hazeldine Warren records the discovery at Graig-lwid, Penmaenmawr, of an important prehistoric site where the manufacture of axes of the Neolithic type was extensively carried on. Penmaenmawr Mountain and Graig-lwid form an oval intrusion of igneous rock, which is extensively quarried for road-metal and building stone. Neolithic remains are generally scarce in North Wales, but Sir John Evans records the discovery of some axes at Dwygyfylchi, in Carnarvonshire, the adjoining village to Penmaenmawr. The axes were made of scree material—that is to say, angular blocks of rock broken up by frost along its natural joint-planes. It is certain that there was a very large output of axes from this factory, and some of them must have passed to long distances in the course of barter and along trade routes during hunting expeditions or hostile raids, tribal migrations, and the like. It is possible that some examples in collections made of felsite or felstone may ultimately be traced to this factory.

IN the Journal of the Torquay Natural History Society (vol. ii., No. 6, 1920) Mr. H. J. Lowe discusses "The Needles of Kent's Cavern with reference to Needle Origin." He thinks that the modern implement originated in prehistoric times in the course of attempts made to sew skins together for use as clothing. The simplest method is to attempt to push the thread through when piercing the hole for it, and the advance made was by getting the idea of a hole in the awl through which the thread could go and be thrust through the skin with the awl or bodkin. In support of this theory a bone needle has recently been found in Kent's Cavern, which Mr. Lowe regards as "an unique specimen of Palæolithic man's bone implement, made for use as a needle." In this specimen "its blunt end will permit strong pressure and twisting by the end of the thumb without abrading the skin or causing a sore, and with one thread passing before the thumb, to be held taut with the other by the closed three fingers, the implement could be held firmly to the thumb and vertically to the skin by one hand, while the other would be free for holding and adjusting the skin while the needle was being pushed through it." It will be interesting to ascertain whether other examples of such an implement are available in collections, and if Mr. Lowe's view is correct.

WE have recently received the first volume (124 pp.) and Nos. 1–2 (32 pp.) of the second volume of *Bollettino della Società Italiana per lo Studio della Alimentazione*, published from the Museum of Natural History in Florence. The bulletin contains original articles on problems connected with food and nutrition —*e.g.* the milk-food of infants, the present soldier's ration in Italy, the culture of carp, and the preservation of hen's eggs. About half of each issue is devoted to abstracts of memoirs on the chemistry and physiology of nutrition, the analysis of food, adulteration, dietetics, the production and preparation of food, the nutrition of animals, and diseases of man and animals arising from food, *e.g.* deficiency diseases.

IN the *Lancashire and Cheshire Naturalist*, vol. xiii., No. 2, August, 1920, Miss Annie Dixon reports on the gatherings of protozoa made from a pond in Didsbury, from September, 1918, to March, 1919, and appends a table of the species found, about 100 in number, showing in which months they occur. A previous report dealt with the protozoan fauna of this pond during the period March to September, 1918. Among the more noteworthy species recorded may be mentioned *Archerina Boltoni,* which was very common during one week in April, 1918, but has not re-appeared; and *Mastigamoeba aspera,* which was found in small numbers in September and October, 1918. It is to be hoped that the study of the protozoa of this pond and the recording of the seasonal occurrence of the various species will be continued.

ZOOLOGISTS, and especially field-naturalists, will be interested in a short paper on the occurrence of Protohydra in England, by Prof. S. J. Hickson, in the current issue of the *Quarterly Journal of Microscopical Science* (vol. lxiv., part 4). *Protohydra Leuckartii* was discovered rather more than half a century ago, and, although apparently very rarely met with since, it has always been regarded with especial interest as one of the simplest—though not necessarily the most primitive—of the Cœlenterata, being, in fact, a Hydra without any tentacles. It has now turned up in abundance in pools in the tidal marshes of the River Hamble, near Southampton, and has also been recorded from the Laira River, near Plymouth. Unfortunately, though it has been observed by Prof. Hickson and Mr. Herbert Ashby for four successive years, no new light is forthcoming as to its life-history, no medusoids and no sexual method of reproduction, but only transverse fission, having been observed.

A MONOGRAPH of the South Asian, Papuan, Melanesian, and Australian frogs of the genus Rana, by Dr. G. A. Boulenger, forms vol. xx. (226 pp., June, 1920) of the Records of the Indian Museum. Dr. Boulenger has grouped the series, so far as possible, according to their probable phylogenetic relationships, and in order to do this has laid down the characters which might be expected to occur in a theoretical prototype from which phyletic lines may be drawn up. Among Asiatic species he regards *Rana hexadactyla* as the nearest approach to the ideal prototype. He groups the 125 species considered into seven natural sections, the first of which is the *hexadactyla*-section from which three others can be derived. The remaining three sections are derived from other ancestral sources. A table of the characters of the nine subgenera of Rana and excellent synoptic keys of the species are given. Detailed descriptions of the species follow, and tables are supplied giving measurements of the different parts of the body of adult and half-grown specimens in order to convey exact information on these important matters, and also to show the amount of individual variation.

PAMPHLET No. 11 of the Economic Series published by the British Museum (Natural History) has recently appeared. It is written by Dr. Gahan, the keeper of the entomological department, and deals with furniture beetles, their life-histories and preventive measures. Not infrequently articles of furniture, or some part of the woodwork in the house, are seriously damaged by the larvæ of certain beetles, of which we have about five species in this country. The common furniture beetle (*Anobium punctatum,* De G.) is the most usual enemy; the death-watch beetle (*Xestobium rufovillosum,* De G.) seldom attacks movable furniture, and more usually affects the timbers of old houses, etc.; while the powder-pest beetles (Lyctus) mostly affect sapwood, and, unless treated with a preservative beforehand, this part is unsuitable for furniture-making. The above types of beetles are well described in this useful little brochure, and clearly figured. Wherever it can be safely applied, treatment by heat is one of the best methods of dealing with affected furniture. In other cases resort has to be made to fumigation with a poisonous gas or vapour. As a third alternative, direct application of a liquid, such as benzene, carbon tetrachloride, or terebene, may be adopted. Anyone troubled with these pests is advised to obtain this pamphlet, which can be purchased at the Museum for the sum of 6*d*.

M. MEUNISSIER has published (*Journal of Genetics,* vol. x., No. 1) a short account of some genetic results obtained by the late M. Philippe de Vilmorin on the colour of the hilum or point of attachment of the pea. One variety of garden pea has a black hilum or "eye," and in crosses with other varieties and species this was found to behave as a simple dominant. In several crosses of varieties in which both parents had an uncoloured hilum, the black hilum appeared in the offspring—in some cases in all the offspring, in others in only a portion of them, and in still others only a few seeds developed the black hilum. Whether such cases are to be looked upon as variations, or, in the latter case, as bud mutations, can only be determined by further breeding experiments. They represent an interesting departure from the usual Mendelian behaviour.

BEFORE the war the medical opium trade was largely in the hands of Turkey, and the Indian opium poppy, although belonging to the same species (*Papaver somniferum*) as the Turkish, was found to have a lower morphine content. In order to replace the foreign product by one produced within the Empire, an effort is being made to produce by breeding experiments a race with a high content and a good yield. Messrs. H. Martin Leake and B. Ram Pershad (*Journal of Genetics,* vol. x., No. 1) expect, by selection and crossing of the numerous Indian varieties of opium poppy, to produce a race with the desired qualities. The preliminary paper deals with the numerous colour varieties. The colour patterns are independent of opium content, but are a useful index of purity in the various races. Chemical investigations have disclosed races yielding as much as 18 per cent. morphine.

THE first of the Memoirs of the Botanical Survey of South Africa has been issued by the Union Department of Agriculture. It comprises an account of the Phanerogamic flora of the Divisions of Uitenhage and Port Elizabeth by Dr. S. Schonland. In July, 1918, an Advisory Committee for the Botanical Survey of the Union was appointed by the Minister of Agriculture, consisting of botanists from each of the four provinces, with the chief of the division of botany and plant pathology as director of the Survey. The botanists comprising the Committee are each in charge of different administrative areas into which the Union has been divided for purposes of the Survey. It was agreed that as a basis of the Survey the preparation of regional floras should be taken in hand and local vegetation surveys prepared, and the present contribution is the first of these regional floras.

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Scientific Studies of Non-ferrous Alloys.*

By C. T. HEYCOCK, M.A., F.R.S.

THE production of metals and their alloys undoubtedly constitutes the oldest of those chemical arts which ultimately expanded into the modern science of chemistry, with all its overwhelming mass of experimental detail and its intricate interweaving of theoretical interpretation of the observed facts. Tubal-cain lived during the lifetime of our common ancestor, and was "an instructor of every artificer in brass and iron"; and although it may be doubted whether the philologists have yet satisfactorily determined whether Tubal-cain was really acquainted with the manufacture of such a complex metallic alloy as brass, it is certain that chemical science had its beginnings in the reduction of metals from their ores and in the preparation of useful alloys from those metals. In fact, metallic alloys, or mixtures of metals, have been used by mankind for the manufacture of implements of war and of agriculture, of coinage, statuary, cooking vessels, and the like from the very earliest times.

In the course of past ages an immense amount of practical information has been accumulated concerning methods of reducing metals, or mixtures of metals, from their ores, and by subsequent treatment, usually by heating and cooling, of adapting the resulting metallic product to the purpose for which it was required. Until quite recent times, however, the whole of this knowledge was entirely empirical in character, because it had no foundation in general theoretical principles; it was collected in haphazard fashion in accordance with that method of trial and error which led our forerunners surely, but with excessive expenditure of time and effort, to valuable results.

To-day I purpose dealing chiefly with the non-ferrous alloys, not because any essential difference in type exists between the ferrous and non-ferrous alloys, but merely because the whole field presented by the chemistry of the metals and their alloys is too vast to be covered in any reasonable length of time.

The earliest recorded scientific investigations on alloys were made in 1722 by Réaumur, who employed the microscope to examine the fractured surfaces of white and grey cast-iron and steel. In 1808 Widmanstätten cut sections from meteorites, which he polished and etched. The founder, however, of modern metallography is undoubtedly H. C. Sorby, of Sheffield. Sorby's early petrographic work on the examination of thin sections of rock under the microscope led him to a study of meteorites and of iron and steel, and in a paper read before the British Association in 1864 he describes briefly (I quote his own words) how sections "of iron and steel may be prepared for the microscope so as to exhibit their structure to a perfection that leaves little to be desired. They show various mixtures of iron, and two or three well-defined compounds of iron and carbon, graphite, and slag; these constituents, being present in different proportions and arranged in various manners, give rise to a large number of varieties of iron and steel, differing by well-marked and very striking peculiarities of structure." The methods described by Sorby for polishing and etching alloys and his method of vertical illumination (afterwards improved by Beck) are employed to-day by all who work at this branch of metallography.

From 1854–68 Mattheisen published in the Reports of the British Association and in the Proceedings and Transactions of the Royal Society a large number of papers on the electrical conductivity, tenacity, and specific gravity of pure metals and alloys. He concluded that alloys are either mixtures of definite chemical compounds with an excess of one or other metal, or solutions of the definite alloy in the excess of one of the metals employed, forming in their solid condition what he called a solidified solution. This idea of a solidified solution has developed into a most fruitful theory upon which much of our modern notions of alloys depends. Although, at the time, the experiments on the electrical conductivity did not lead to very definite conclusions, the method has since been used with great success in testing for the presence of minute quantities of impurities in the copper used for conductors. In the *Philosophical Magazine* for 1875 F. Guthrie, in a remarkable paper quite unconnected with alloys, gave an account of his experiments on salt solutions and attached water. He was led to undertake this work by a consideration of a paper by Dr. J. Rea, the Arctic explorer, on the comparative saltness of freshly formed and of older ice-floes. Guthrie showed that the freezing point of solutions was continuously diminished as the percentage of common salt increased, and that this lowering increased up to 23·6 per cent. of salt, when the solution solidified as a whole at about 22° C. He further showed, and this is of great importance, that the substance which first separated from solutions more dilute than 23·6 per cent. was pure ice. To the substance which froze as a whole, giving crystals of the same composition as the mother-liquor, he gave the name "cryohydrate."

In the *Philosophical Magazine* for 1876 Guthrie gave an account of his experiments, using solvents other than water, and states that the substances which separate at the lowest temperature are neither atomic nor molecular; this lowest melting-point mixture of two bodies he names the eutectic mixture. In the same paper he details the methods of obtaining various eutectic alloys of bismuth, lead, tin, and cadmium.

We have in these papers of Guthrie's the first important clue to what occurs on cooling a fused mixture of metals. The researches of Sorby and Guthrie, undertaken as they were for the sake of investigating natural phenomena, are a remarkable example of how purely scientific experiment can lead to most important practical results. It is not too much to claim for these investigators the honour of being the originators of all our modern ideas of metallurgy. Although much valuable information had been accumulated, no rapid advance could be made until some general theory of solution had been developed. In 1878 Raoult first began his work on the depression of the freezing point of solvents due to the addition of dissolved substances, and he continued at frequent intervals to publish the results of his experiments up to the time of his death in 1901.

In a paper in the *Zeit. Physikal. Chem.* for 1888 on "Osmotic Pressure in the Analogy between Solutions and Gases," van't Hoff showed that the experiments of Pfeffer on osmotic pressure could be explained on the theory that dissolved substances were, at any rate for dilute solutions, in a condition similar to that of a gas; that they obeyed the laws of Boyle, Charles, and Avogadro; and that on this assumption the depression of the freezing point of a solvent could be calculated by means of a simple formula. He also showed that the exceptions which occurred to Raoult's

* From the opening address of the President of Section B (Chemistry) delivered at the Cardiff meeting of the British Association on August 24.

laws, when applied to aqueous solutions of electrolytes, could be explained by the assumption, first made by Arrhenius, that these latter in solution are partly dissociated into their ions. The result of all this work was to establish a general theory applicable to all solutions which has been widespread in its applications. From this time the study of alloys began to make rapid progress.

The experiments of Laurie, Tannman, and Neville and myself in 1888 and 1889 helped to establish the similarity between the behaviour of metallic solutions or alloys and that of aqueous and other solutions of organic compounds in organic solvents. That our experiments were correct seemed probable from the agreement between the observed depression of the freezing point and the value calculated from van't Hoff's formula for the case of those few metals the latent heats of fusion of which had been determined with any approach to accuracy.

Our experiments, afterwards extended to other solvents, led to the conclusion that in the case of most metals dissolved in tin the molecular weight is identical with the atomic weight; in other words, that the metals in solution are monatomic. This conclusion, however, involves certain assumptions. Sir William Ramsay's experiments on the lowering of the vapour pressure of certain amalgams point to a similar conclusion.

So far our work had been carried out with mercury thermometers, standardised against a platinum resistance pyrometer, but it was evident that, if it was to be continued, we must have some method of extending our experiments to alloys which freeze at high temperatures. The thermo-couple was not at this stage a trustworthy instrument; fortunately, however, Callendar and Griffiths had brought to great perfection the electrical resistance pyrometer (Phil. Trans., A, 1887 and 1891). Dr. E. H. Griffiths kindly came to our aid, and with his help we installed a complete electrical resistance set. As at this time the freezing points of pure substances above 300° were not known with any degree of accuracy, we began by making these measurements:—

Table of Freezing Points.

—	Carnelly's Tables	Holborn and Wien, 1892	Callendar and Griffiths, 1892	Neville and Heycock, 1895	Burgess and Le Chatelier, 1912. High Temperature Measurements
Tin ...	—	—	231·7	231·9	231·9
Zinc ...	433	—	417·6	419·0	419·4
Lead ...	—	—	—	327·6	327·4
Antimony...	432	—	—	629·5	630·7 & 629·2
Magnesium	—	—	—	632·6[1]	650
Aluminium	700	—	—	654·5[2]	658
Silver ...	954	968	972	960·7	960·9
Gold ...	1045	1072	1037	1061·7	1062·4
Copper ...	1054	1082	—	1080·5	1083
Sulphur B.P.	448	—	444·53	—	444·7

[1] Contaminated with silicon. [2] Known to be impure.

With the exception of silver and gold, these metals were the purest obtainable in commerce.

During the period that the above work on non-ferrous alloys was being done, great progress was being made in the study of iron and steel by Osmond and Le Chatelier. In 1890 the Institution of Mechanical Engineers formed an Alloys Research Committee. This committee invited Prof. (afterwards Sir William) Roberts-Austen to undertake research work for it. The results of his investigations are contained in a series of five valuable reports extending from 1891 to 1899, published in the Journal of the institution. The fifth is of especial importance, because, besides a description of the thermal effects produced by carbon, which he carefully plotted and photographed, he described the microscopical appearance of the various constituents of iron. The materials of this report, together with the work of Osmond and others on steel and iron, provided much of the material on which Prof. Bakhuis Roozeboom founded the iron-carbon equilibrium diagram. Reference should also be made to the very valuable paper by Stansfield on the present position of the solution theory of carbonised iron (Journ. Iron and Steel Inst., vol. xi., 1900, p. 317). It may be said of this fifth report, and of the two papers just referred to, that they form the most important contribution to the study of iron and steel that has ever been published. Although the diagram for the equilibrium of iron and carbon does not represent the whole of the facts, it affords the most important clue to these alloys, and undoubtedly forms the basis of most of the modern practice of steel manufacture. Many workers, both at home and abroad, were now actively engaged in metallurgical work—Stead, Osmond, Le Chatelier, Arnold, Hadfield, Carpenter, Ewing, Rosenhain, and others too numerous to mention.

In 1897 Neville and I determined the complete freezing-point curve of the copper-tin alloys, confirming and extending the work of Roberts-Austen, Stansfield, and Le Chatelier; but the real meaning of the curve remained as much of a mystery as ever. Early in 1900 Sir G. Stokes suggested to us that we should make a microscopic examination of a few bronzes as an aid to the interpretation of the singularities of the freezing-point curve. An account of this work, which occupied us for more than two years, was published as the Bakerian lecture of the Royal Society in February, 1903. Whilst preparing a number of copper-tin alloys of known composition we were struck by the fact that the crystalline pattern which developed on the free surface of the slowly cooled alloys was entirely unlike the structure developed by polishing and etching sections cut from the interior; it therefore appeared probable that changes were going on within the alloys as they cooled. In the hope that, as Sorby had shown in the case of steel, we could stereotype or fix the change by sudden cooling, we melted small ingots of the copper-tin alloys and slowly cooled them to selected temperatures and then suddenly chilled them in water. The results of this treatment were communicated to the Royal Society and published in the Proceedings of February, 1901.

To apply this method to a selected alloy we first determined its cooling curve by means of an automatic recorder, the curve usually showing several halts or steps in it. The temperature of the highest of these steps corresponded with a point on the liquidus, *i.e.* when solid first separated out from the molten mass. To ascertain what occurred at the later halts, ingots of the melted alloy were slowly cooled to within a few degrees above and below the halt and then chilled.

The method of chilling also enabled us to fix, with some degree of accuracy, the position of points on the solidus. If an alloy, chilled when it is partly solid and partly liquid, is polished and etched, it will be seen to consist of large primary combs embedded in a matrix consisting of mother-liquor, in which are disseminated numerous small combs, which we called "chilled primary." By repeating the process at successively lower and lower temperatures we obtained a point at which the chilled primary no longer formed, *i.e.* the upper limit of the solidus.

Although we made but few determinations of the physical properties of the alloys, it is needless to say how much they vary with the temperature and with the rapidity with which they are heated or cooled.

From a consideration of the singularities in the liquidus curve, coupled with the microscopic examination of slowly cooled and chilled alloys, we were able to divide the copper-tin alloys into certain groups having special qualities.

So far I have directed attention to some of the difficulties encountered in the examination of binary alloys. When we come to ternary alloys the difficulties of carrying out an investigation are enormously increased, whilst with quaternary alloys they seem almost insurmountable; in the case of steels containing always six, and usually more, constituents we can hope at present to get information only by purely empirical methods. Large numbers of the elements and their compounds, which originally were laboriously prepared and investigated in the laboratory and remained dormant as chemical curiosities for many years, have, in the fullness of time, taken their places as important, and indeed essential, articles of commerce. I may remark that even during my own lifetime I have seen a vast number of substances transferred from the category of rare laboratory products to that which comprises materials of the utmost importance to the modern metallurgical industries. A few decades ago aluminium, chromium, cerium, thorium, tungsten, manganese, magnesium, molybdenum, nickel, calcium and calcium carbide, carborundum, and acetylene were unknown outside the chemical laboratory of the purely scientific investigator; to-day, these elements, their compounds and alloys, are amongst the most valuable of our industrial metallic products. They are essential in the manufacture of high-speed steels, of armour-plate, of filaments for the electric bulb lamp, of incandescent gas mantles, and of countless other products of modern scientific industry. All these metallic elements and compounds were discovered, and their industrial uses foreshadowed, during the course of the purely academic research work carried out in our universities and colleges; all have become the materials upon which great and lucrative industries have been built up. Although the scientific worker has certainly not exhibited any cupidity in the past, and has been content to rejoice in his own contributions to knowledge and to see great manufacturing enterprises founded upon his work, it is clear that the obligation devolves upon those who have reaped in the world's markets the fruit of scientific discovery to provide from their harvest the financial aid without which scientific research cannot be continued.

The truth of this statement is well understood by those of our great industrial leaders who are engaged in translating the results of scientific research into technical practice. As evidence of this I may quote the magnificent donation of 210,000*l.* by the British oil companies towards the endowment of the school of chemistry in the University of Cambridge; the noble bequest of the late Dr. Messel, one of the most enlightened of our technical chemists, for defraying the cost of scientific research; the gifts of the late Dr. Ludwig Mond towards the upkeep and expansion of the Royal Institution, one of the strongholds of British chemical research; and the financial support given by the Goldsmiths' and others of the great City of London Livery Companies (initiated largely by the late Sir Frederick Abel, Sir Frederick Bramwell, and Mr. George Matthey) to the foundation of the Imperial College of Science and Technology. The men who initiated these gifts have been themselves intimately associated with developments in both science and industry; they have understood that the field must be prepared before the crop can be reaped. Fortunately, our great chemical industries are, for the most part, controlled and administered by men fully conversant with the mode in which technical progress and prosperity follow upon scientific achievement; and it is my pleasant duty to record that within the last few weeks the directors of one of our greatest chemical manufacturing concerns have, with the consent of their shareholders, devoted 100,000*l.* to research. Doubtless other chemical industries will in due course realise what they have to gain by an adequate appreciation of pure science. If the effort now being made to establish a comprehensive scheme for the resuscitation of chemical industry within our Empire is to succeed, financial support on a very liberal scale must be forthcoming from the industry itself for the advancement of purely scientific research. This question has been treated recently in so able a fashion by Lord Moulton that nothing now remains but to await the results of his appeal for funds in aid of the advancement of pure science.

In order to prevent disappointment and a possible reaction in the future in those who endow pure research, it is necessary to give a word of warning. It must be remembered that the history of science abounds in illustrations of discoveries, regarded at the time as trivial, which have in after-years become epoch-making. In illustration I would cite Faraday's discovery of electro-magnetic induction. He found that when a bar-magnet was thrust into the core of a bobbin of insulated copper wire, the terminals of which were connected with a galvanometer, a momentary current was produced; while on withdrawing the magnet a momentary reverse current occurred—a purely scientific experiment destined in later years to develop into the dynamo and with it the whole electrical industry. Another illustration may be given: Guyton de Morveau, Northmore, Davy, Faraday, and Cagniard Latour between 1800 and 1850 were engaged in liquefying many of the gases. Hydrogen, oxygen, nitrogen, marsh gas, carbon monoxide, and nitric oxide, however, resisted all efforts until the work of Joule and Andrews gave the clue to the causes of failure. Some thirty years later, by careful application of the theoretical considerations, all the gases were liquefied. The liquefaction of oxygen and nitrogen now forms the basis of a very large and important industry.

Such cases can be multiplied indefinitely in all branches of science.

Perhaps the most pressing need of the present day lies in the cultivation of a better understanding between our great masters of productive industry, the shareholders to whom they are in the first degree responsible, and our scientific workers; if, by reason of any turbidity of vision, our large manufacturing corporations fail to discern that, in their own interest, the financial support of purely scientific research should be one of their first cares, technical advance will slacken, and other nations adopting a more far-sighted policy will forge ahead in science and technology. It should, I venture to think, be the bounden duty of everyone who has at heart the aims and objects of the British Association to preach the doctrine that in closer sympathy between all classes of productive labour, manual and intellectual, lies our only hope for the future. I cannot do better than conclude by quoting the words of Pope, one of our most characteristically British poets:

> By mutual confidence and mutual aid
> Great deeds are done and great discoveries made.

Economic and Educational Aspects of Zoology.*

By PROF. J. STANLEY GARDINER, M.A., F.R.S.

GREAT as have been the results in physical sciences applied to industry, the study of animal life can claim discoveries just as great. Their greatest value, however, lies, not in the production of wealth, but rather in their broad applicability to human life. Man is an animal, and he is subject to the same laws as are other animals. He learns by the experience of his forbears, but he learns also by the consideration of other animals in relationship to their fellows and to the world at large. The whole idea of evolution, for instance, is of indescribable value; it permeates all life to-day; and yet Charles Darwin, whose researches did more than any others to establish its facts, is too often known to the public only as "the man who said we came from monkeys."

Whilst, first and foremost, I would base my claim for the study of animal life on this consideration, we cannot neglect the help it has given to the physical welfare of man's body. It is not out of place to direct attention to the manner in which pure zoological science has worked hand-in-hand with the science of medicine. Harvey's experimental discovery of the circulation of the blood laid the foundation for that real knowledge of the working of the human body which is at the basis of medicine; our experience of the history of its development gives us good grounds to hope that the work that is now being carried out by numerous researchers under the term "experimental" will ultimately elevate the art of diagnosis into an exact science. Harvey's work, too, mostly on developing chicks, was the starting-point for our knowledge of human development and growth. Instances in medicine could be multiplied wherein clinical treatment has been rendered possible only by laborious research into the life-histories of certain parasites preying often on man and other animals alternately. In this connection there seems reason at present for the belief that the great problem of medical science, cancer, will reach its solution from the zoological side. A pure zoologist has shown that typical cancer of the stomach of the rat can be produced by a parasitic threadworm (allied to that found in pork, Trichina), this having as a carrying host the American cockroach, brought over to the large warehouses of Copenhagen in sacks of sugar. Our attack on such parasites is made effective only by what we know of them in lower forms, which we can deal with at will. Millions of the best of our race owe their lives to the labours of forgotten men of science who laid the foundations of our knowledge of the generations of insects and flat-worms, the modes of life of lice and ticks, the physiology of such lowly creatures as Amœba and Paramecium, and of parasitic disease—malaria, Bilharziasis, typhus, trench fever, and dysentery.

Of immense economic importance in the whole domain of domestic animals and plants was the rediscovery early in the present century of the completely forgotten work of Gregor Mendel on cross-breeding, made known to the present generation largely by the labours of a former president of this Association, who, like a true man of science, claims no credit for himself. We see results already in the few years that have elapsed in special breeds of wheat, in which have been combined with exactitude the qualities man desires. The results are in the making—and this is true of all things in biology—but can anyone doubt that the breeding of animals is becoming an exact science? We have got far, perhaps, but we want to get much further in our understanding of the laws governing human heredity; we have to establish immunity to disease. Without the purely scientific study of chromosomes (the bodies which carry the physical and mental characteristics of parents to children) we could have got nowhere, and to reach our goal we must know more of the various forces which in combination make up what we term life.

In agricultural sciences we are confronted with pests in half a dozen different groups of animals. We have often to discover which of two or more is the damaging form, and the difficulty is greater where the damage is due to association between plant and animal pests. Insects are, perhaps, the worst offenders, and our basal knowledge of them as living organisms—they can do no damage when dead, and perhaps pinned in our showcases—is due to Redi, Swammerdam, and to Réaumur in the middle of the eighteenth century. Our present successful honey production is founded on the curiosity of these men in respect to the origin of life and the generation of insects. The fact that most of the dominant insects have a worm (caterpillar or maggot) stage of growth, often of far longer duration than that of the insects, has made systematic descriptive work on the relation of worm and insect of peculiar importance. I hesitate, however, to refer to catalogues in which perhaps a million different forms of adults and young are described. Nowadays we know, to a large degree, with what pests we deal, and we are seeking remedies. We fumigate and we spray, spending millions of money, but the next remedy is in the use of free-living enemies or parasites to prey on the insect pests. The close correlation of anatomy with function is of use here in that life-histories, whether parasitic, carnivorous, vegetarian, or saprophagous, can be foretold in fly-maggots from the structure of the front part of their gut (pharynx); we know whether any maggot is a pest, harmless, or beneficial.

I will not disappoint those who expect me to refer more deeply to science in respect to fisheries, but its operations in this field are less known to the public at large. The opening up of our north-western grounds and banks is due to the scientific curiosity of Wyville Thomson and his *confrères* as to the existence or non-existence of animal life in the deep sea. It was sheer desire for knowledge that attracted a host of inquirers to investigate the life-history of river-eels. The wonder of a fish living in our shallowest pools and travelling two or three thousand miles to breed, very likely on the bottom in 2000 fathoms, and subjected to pressures varying from 14 lb. to 2 tons per square inch, is peculiarly attractive. It shows its results in regular eel-farming, the catching and transplantation of the baby eels out of the Severn into suitable waters which cannot, by the efforts of Nature alone, be sure of their regular supply. Purely scientific observations on the life-histories of flat-fish—these were largely stimulated by the scientific curiosity induced by the views of Lamarck and Darwin as to the causes underlying their anatomical development—and on the feeding value and nature of Thisted Bredning and the Dogger Bank, led to the successful experiments on transplantation of young

* From the opening address of the President of Section D (Zoology) delivered at the Cardiff meeting of the British Association on August 24.

plaice to these grounds and the remarkable growth-results obtained, particularly on the latter. Who can doubt that this "movement of herds" is one of the first results to be applied in the farming of the North Sea so soon as the conservation of our fish supply becomes a question of necessity?

The abundance of mackerel is connected with the movements of Atlantic water into the English Channel and the North Sea—movements depending on complex astronomical, chemical, and physical conditions. They are further related to the food of the mackerel, smaller animal life which dwells only in these Atlantic waters. These depend, as indeed do all animals, on that living matter which possesses chlorophyll for its nutrition, and which we call plant. In this case the plants are spores of algæ, diatoms, etc., and their abundance as food again depends on the amount of the light of the sun—the ultimate source, it might seem, of all life.

A method of ascertaining the age of fishes was sought purely to correlate age with growth in comparison with the growth of air-living vertebrates. This method was found in the rings of growth in the scales, and now the ascertaining of age-groups in herring shoals enables the Norwegian fishermen to know with certainty what possibilities and probabilities are before them in the forthcoming season. From the work on the blending together of Atlantic with Baltic and North Sea water off the Baltic Bight and of the later movements of this "bankwater," as it is termed, into the Swedish fjords can be understood, year by year, the Swedish herring fishery. It is interesting that these fisheries have been further correlated with cycles of sun-spots, and also with longer cycles of lunar changes.

The mass of seemingly unproductive scientific inquiries undertaken by the United States Bureau of Fisheries thirty to fifty years ago was the forerunner of their immense fish-hatching operations, whereby billions of fish-eggs are stripped year by year and the fresh waters of that country made into an important source for the supply of food. The study of the growth-stages of lobsters and crabs has resulted in sane regulations to protect the egg-carrying females, and in some keeping up of the supply in spite of the enormously increased demand. Lastly, the study of free-swimming larval stages in Mollusca, stimulated immensely by their similarity to larval stages in worms and starfishes, has given rise to the establishment of a successful pearl-shell farm at Dongonab, in the Red Sea, and of numerous fresh-water mussel fisheries in the southern rivers of the United States, to supply small shirt-buttons.

Fishery investigation was not originally directed to a more ambitious end than giving a reasonable answer to a question of the wisdom or unwisdom of compulsorily restricting commercial fishing, but it was soon found that this answer could not be obtained without the aid of pure zoology. The spread of trawling—and particularly the introduction of steam trawling during the last century—gave rise to grave fears that the stock of fish in home waters might be very seriously depleted by the use of new methods. We first required to know the life-histories of the various trawled fish, and Sars and others told us that the eggs of the vast majority of the European marine food species were pelagic—in other words, that they floated, and thus could not be destroyed, as had been alleged. Trawl-fishing might have to be regulated all the same, for there might be an insufficient number of parents to keep up the stock. It was clearly necessary to know the habits, movements, and distribution of the fishes, for all were not throughout their life or at all seasons found on the grounds it was practicable to fish.

But why multiply instances of the applications of zoology as a pure science to human affairs? Great results are asked for on every side of human activities. The zoologist, if he be given a chance to live and to hand on his knowledge and experience to a generation of pupils, can answer many of them. He is increasingly getting done with the collection of anatomical facts, and turning more and more to the why and how animals live. We may not know in our generation or in many generations what life is, but we can know enough to control that life. The consideration of the fact that living matter and water are universally associated opens up high possibilities. The experimental reproduction of animals, without the interposition of the male, is immensely interesting; where it will lead no one can foretell. The association of growth with the acidity and alkalinity of the water is a matter of immediate practical importance, especially to fisheries. The probability of dissolved food-material in sea- and river-water, independent of organised organic life and absorbable over the whole surfaces of animals, is clearly before us. Is it possible that that dissolved material may be even now being created in Nature without the assistance of organic life? The knowledge of the existence in food of vitamines, making digestible and usable what in food would otherwise be wasted, may well result in economies of food that will for generations prevent the necessity for the artificial restriction of populations. The parallel between these vitamines and something in sea-water may quite soon apply practically to the consideration of all life in the sea. Finally, what we know of the living matter of germ-cells puts before us the not impossible hope that we may influence for the better the generations yet to come.

So far I have devoted my attention primarily, in this survey of the position of zoology, to the usefulness of the subject. Let us now note where we stand in respect to other subjects and in meeting the real need for wide zoological study.

Let me give a few facts which have their sweet and bitter for us who make zoology our life-work. During the war we wanted men who had passed the honours schools in zoology—and hence were presumably capable of doing the work—to train for the diagnosis of protozoal disease. We asked for all names from 1905 to 1914 inclusive, and the average worked out at under fourteen per year from all English universities: an average of one student per university per year. In the year 1913–14 every student who had done his honours course in zoology in 1913 could, if he had taken entomology as his subject, have been absorbed into the economic applications of that subject. Trained men were wanted to undertake scientific fishery investigations, and they could not be found. Posts were advertised in animal breeding, in helminthology, and in protozoology, three other economic sides of the subject. The Natural History Museum wanted systematists, and there were many advertisements for teachers. How many of these posts were filled I do not know, but it is clear that not more than one-half—or even one-third—can have been filled efficiently. Can any zoologist say that all is well with his subject in the face of these deficiencies?

The demands for men in the economic sides of zoology are continually growing, and it is the business of universities to try to meet these demands. There are Departments of Government at home and in our Colonies which, in the interests of the people they govern, wish to put into operation protective measures, but cannot do so because there are not the men with the requisite knowledge and common sense required for inspectorates. There are others that wish for research to develop so as to conserve existing industries as well as to discover new ones, and they, too, are compelled to mark time.

In default, or in spite, of the efforts of the schools of pure zoology, attempts are being made to set up special training schools in fisheries, in entomology, and in other economic applications of zoology. Each branch is regarded as a science, and the supporters of each suppose they can, from the commencement of a lad's scientific training, give specialised instruction in each. The researcher in each has to do the research which the economic side requires. But he cannot restrict his education to one science; he requires to know the principles of all sciences; he must attempt to understand what life is. Moreover, his specialist knowledge can seldom be in one science. The economic entomologist, however deep his knowledge of insects may be, will find himself frequently at fault in distinguishing cause and effect unless he has some knowledge of mycology. The protozoologist must have an intimate knowledge of unicellular plants, bacterial and other. The animal-breeder must know the work on cross-fertilisation of plants. The fisheries man requires to understand physical oceanography. The helminthologist and the veterinary surgeon require an intimate knowledge of a rather specialised "physiology." All need knowledge of the comparative physiology of animals in other groups beyond those with which they deal, to assist them in their deductions and to aid them to secure the widest outlook. It is surely a mistake, while the greatest scientific minds of the day find that they require the widest knowledge, to endeavour to get great scientific results out of students whose training has been narrow and specialised. Such specialisation requires to come later, and can replace nothing. This short cut is the longest way round. The danger is not only in our science, but in every science.

Surely the time has now come for us to lift our eyes from our tables of groups and families, and, on the foundations of the knowledge of these, to work on the processes going on in the living body, the adaptation to environment, the problems of heredity, and at many another fascinating hunt in unknown country. Let us teach our students not only what is known, but, still more, what is unknown, for in the pursuit of the latter we shall engage eager spirits who care naught for collections of corpses. My own conviction is that we are in danger of burying our live subject along with our specimens in museums.

As a result of the wrong teaching of zoology, we see proposals to make so-called "Nature-study" in our schools purely botanical. Is this proposal made in the interests of the teacher or of the children? It surely cannot be for "decency" if the teaching is honest, for the phenomena are the same, and there is nothing "indecent" common to all life. "The proper study of mankind is man," and the poor child, athirst for information about himself, is given a piece of moss or duckweed, or even a chaste buttercup. Is the child supposed to get some knowledge it can apply economically? Whatever the underlying ideas may be, this course will not best develop the mind to enable it to grapple with all phenomena, the aim of education. If necessary, the school teacher must go to school; he must bring himself up to date in his own time, as every teacher in science has to do; it is the business of universities to help him, for nothing is more important to all science than the foundations of knowledge.

Native Races of the Empire.

AMONG the resolutions adopted by the General Committee of the British Association during the recent meeting at Cardiff, several dealt with problems connected with the native races of the Empire. Of these one referred to the deplorable conditions now prevailing among the aboriginal tribes of Central Australia, of which an account was recently given in these columns (see NATURE, July 8, p. 601). The Association urged upon the Federal Government and the Governments of Western Australia and South Australia the desirability of establishing an absolute reservation upon part of the lands now occupied by the tribes within the jurisdiction of these Governments in order that they might be preserved from extinction. The resolution further emphasised the necessity of establishing a medical service for the natives in order to check the ravages of disease by which they are now rapidly being reduced in numbers. It may be hoped that the influence of the Association will add force to the movement which has already been set on foot in South Australia, and induce the Governments concerned to take action in this matter.

A second resolution of the Association dealt with the desirability of initiating an anthropological survey of the natives of Western Australia. In this State the natives are under the control of Protectors of Aborigines, and are, for the most part, either located on Government farms or stations, or, if employed by private owners, the conditions of their employment are strictly regulated by the Protectors. Notwithstanding the measures taken for their well-being and preservation, which include a medical service and an organised system of food-supply for times of scarcity, they are dwindling in numbers. At the same time, in the changed conditions, the memory of their tribal customs and traditions is being lost. In the interests of science it is, therefore, highly desirable that some record should be made of their language, customs, traditions, and beliefs, as well as of their physical characters, before the older members of the tribes die out.

During the past summer, it will be remembered, Gen. Smuts introduced into the South African Parliament a Bill dealing with the native population. This Bill has been described as embodying the most important proposals in reference to the native problem since the Glen Grey Act. Briefly stated, its main provisions aim at improving the position of the native, and at the same time meeting his claim to a voice in the regulation of his own affairs by developing a system of local government based upon the tribal social organisation. A further resolution of the Association pointed out that any attempt to bring the native population into closer touch with the social and economic development of the country as a whole—the crucial problem of native legislation in South Africa—could hope to be successful only if it were based upon an intimate knowledge of native psychology and customs, and to this end it urged upon the Government of the Union the necessity for the establishment of an Ethnological Bureau for the collection of data and the study of native institutions.

Relativity.

DR. C. E. ST. JOHN gives in the *Observatory* for July some remarks on the search for the Einstein effect in the solar spectrum which was made last year by L. Grebe and A. Bachem at Bonn, and alluded to with approbation in a letter from Dr. Einstein, quoted in NATURE for January 29 last. Dr. St. John thinks that the dispersion of their spectrograph, 1 mm. per Å.U., was too low for work of this character, especially where the lines are so close together; further, the comparison spectrum was not photographed simultaneously, but before and after. The arrangements for eliminating the solar rotation are also not considered to have been exact enough.

Dr. St. John then goes on to criticise their suggested explanation for the failure of some other observers to detect the Einstein shift, which was, in short, that unsymmetrical emission lines become symmetrical in absorption. He shows that this neglects the light radiated by the vapour itself; since the absorbing vapour is at various depths in the sun, the probable result is shown to be an unsymmetrical absorption line. The further argument is made that many of the iron lines are unsymmetrical in the reverse direction to the carbon lines in question, so that if the explanation were true, these lines should give too large an Einstein effect, which they do not.

Dr. St. John concludes by saying that the object of his note is not to deny the existence of the Einstein effect, but merely to throw doubt on the completeness of the proof put forward by Messrs. Grebe and Bachem.

Astr. Nach., 5051, has an article by K. F. Bottlinger in which a possible astronomical test is suggested to distinguish between the relativist view of the speed of light and the earlier view of the stationary æther. He notes the very high radial velocities of the spiral nebulæ and clusters, and concludes that it is, *a priori*, likely that the velocity of our stellar system relatively to the æther is of the same order. If we take it as 1000 km./sec., and also assume that the direction of motion is not distant from the plane of the ecliptic, then eclipses of Jupiter's satellites will be alternately accelerated and retarded by some 14 sec., according as Jupiter lies towards the apex or antapex. The eclipses observed at Harvard make it pretty certain that there is no residual of this amount in the eclipse times; so that either the fixed-æther doctrine of light transmission is wrong or the speed of our system in the æther is only a small fraction of 1000 km./sec. This proposed test differs from the Michelson-Morley experiment in being a first-order effect, while that is of the second order.

University and Educational Intelligence.

Science of August 20 reports that the Harvard University School of Medicine has received 70,000*l.* from the Rockefeller Foundation for the development of psychiatry, and 60,000*l.* for the development of obstetric teaching.

THE *Chemist and Druggist* announces that the chair of chemistry in Berlin University, rendered vacant by the death of E. Fischer, will be filled by Prof. Haber, who will retain also his present position of director of the Emperor William Institute for Physical and Electro-Chemistry.

THE governors of the Northern Polytechnic Institute, Holloway, N.7, are, on September 27, opening a school of rubber technology. There will be day and evening courses designed mainly to train those who have already acquired a thorough knowledge of chemistry and physics and are now desirous of taking up responsible positions of a scientific and technical nature in rubber factories. The school will be in close touch with the industry, as it will be under an advisory committee composed of representatives of the manufacturers, producers, merchants, rubber engineers, etc. The director of the courses is Dr. P. Schidrowitz, who is a leading authority on rubber.

FROM the Simla correspondent of the *Pioneer Mail* for August 6 we learn that the text of the Muslim University Bill has been published. It is proposed to dissolve the Muslim University Association and the Mohammedan Anglo-Oriental College, Aligarh, and to transfer the property of these societies to a new body called "The Aligarh Muslim University." The Bill secures to the Government powers of control, and to the University the assurance of a permanent endowment. The University will be of the teaching and residential type, and its degrees will be recognised by the Government. Special features of the institution will be the instruction of Muslims in Muslim religious education, and the inclusion of departments of Islamic studies.

THE calendar of the Edinburgh and East of Scotland College of Agriculture for the year 1920–21 contains a detailed account of the courses of instruction available at this centre for the degree of B.Sc. of Edinburgh University, for the college diploma in agriculture, and for the college diploma in horticulture. Short courses in agriculture are provided during the winter months for the benefit of farmers and others who are unable to attend the full diploma course; these last for five weeks and extend over two years. In addition, a short course in forestry lasting four weeks may be given during the summer of 1921. The college also acts in an advisory capacity to farmers in the central and south-eastern counties of Scotland. Epidemics of insect or other pests on crops, trees, or live-stock are investigated, and information on farm and dairy management is always available. Manures and seeds for experimental work are tested at specially low rates with the idea of encouraging farmers to conduct experiments and trials in collaboration with the college staff.

THE current issue of the *British Medical Journal* is the annual educational number. As usual, it is addressed mainly to two classes: those who need information as to the course which must be followed in order to become legally qualified practitioners of medicine, and those who, having obtained qualifications to practise, are doubtful as to what particular branch of medicine they should choose as a career. The student is advised to aim at a university degree in medicine at the outset of his career, though it may be desirable to take also a diploma or licence. Warning is also given with regard to the question of expenses. The outlay involved in completing a medical curriculum varies, but 1500*l.* is reckoned to be the minimum for which the training can be accomplished at the present time. For the medical graduate, diplomate, or licentiate, once his name is on the Register of the General Medical Council, many paths are indicated; but he is reminded that whatever the branch of practice chosen, the main reward of medical life is the knowledge of good work well done. Against this it is urged that the spirit of the times is all in favour of the extension and co-ordination of the public health services. This has occasioned an increase in the official medical services, but their position is not well defined at present, and prospects of promotion are uncertain.

THE new session of the Sir John Cass Technical Institute, Aldgate, will commence on Monday, September 27. The courses of instruction provided are especially directed to the technical training of those engaged in chemical, metallurgical, and electrical industries and in trades associated therewith. Special courses of higher technological instruction form a distinctive feature of the work of the institute. The curriculum in connection with the fermentation industries includes courses of instruction in brewing and malting; in the history, cultivation, and use of the hop; and in the micro-biology of the fermentation industries. These courses are arranged for persons engaged in the practical and scientific control of breweries, maltings, and other fermentation industries who desire to acquire a knowledge of the technology and principles underlying their daily operations. A connected series of lectures on fuel and power is also included in the syllabus of the chemistry department for the forthcoming session. In the department of physics and mathematics special courses of lectures will be given in colloids, the methods employed in their investigation and their relation to technical problems; in differential equations and vector analysis; and in the theory and application of mathematical statistics. Full details of the courses are given in the syllabus of the institute, which can be had on application at the office of the institute or by letter to the principal.

ALTHOUGH the scientific study of human and animal nutrition is of even greater importance to this country than to the United States of America, it has attracted fewer workers and received far less financial support here than on the other side of the Atlantic. Consequently, the public-spirited munificence of Mr. John Quiller Rowett in contributing 10,000*l.* towards the endowment of an Institute for Research in Animal Nutrition in connection with the University of Aberdeen and the North of Scotland College of Agriculture is especially to be commended. The new institute, which will appropriately be named the Rowett Research Institute, has already secured the services of two first-rate investigators. Dr. J. B. Orr, the director, was recently associated with Prof. E. P. Cathcart in the conduct of a very important study of the energy output of soldiers, while Dr. R. H. A. Plimmer, chief biochemist in the institute, has had a distinguished career as a research worker in the Physiological Institute of University College, London. An agricultural correspondent, writing in the *Aberdeen Daily Journal* of July 9, directs attention to the enormous economic loss, estimated at 30 millions sterling per annum, due to diseases of animals and plants, while the unsatisfactory state of knowledge respecting problems of human nutrition and food-supply was the subject of a criticism by a committee of the Royal Society. It is obvious that no single institute can cope with the mass of work which urgently needs to be done, but the precedent just established is valuable, and the scientific colleagues of Drs. Orr and Plimmer will look forward with confidence to their future successes in a field of research so far inadequately cultivated.

Societies and Academies.

PARIS.

Academy of Sciences, August 2.—M. Henri Deslandres in the chair.—The president announced the death of Armand Gautier.—G. **Humbert**: The representation of an integral by indefinite Hermite forms in an imaginary quadratic body.—M. **Michkovitch**: Observations of the periodic comet Tempel II. made at the Marseilles Observatory with the Eichens equatorial of 26-cm. aperture. Positions for July 20 and 21 are given, with those of comparison stars. The comet was circular, diameter 5 to 6 seconds of arc, and magnitude 10·2. The nucleus was well defined.—R. **Jarry-Desloges**: Contribution to the study of telescopic images.—P. **Ditisheim**: The determination of the difference of longitude between Greenwich and Paris by chronometers carried by aeroplane. The regular aeroplane service between London and Paris was utilised for the transport of twelve chronometers. The general mean of sixty-one operations was 9m. 20·947s. ±0·027s. for the difference of longitude between Greenwich and Paris.—J. **Villey**: The application of Righi's method to the discussion of Michelson's experiment.—G. **de Rocasolano**: The ageing of colloidal catalysts (platinum, palladium). In the decomposition of hydrogen peroxide solutions by colloidal solutions of platinum, the velocity constant increases with the time between the preparation of the catalyst and its use, reaches a maximum, and then falls. Hydrosols of palladium exhibit similar phenomena.—Er. **Torporescu**: The removal of copper oxide and nickel oxide from solutions by precipitates of ferric oxide.—Ch. **Depéret** and P. **Mazeran**: The Bresse of Chalon and its Quaternary terraces.—L. **Mayet**, P. **Nugue**, and J. **Dareste de la Chavanne**: The discovery of a skeleton of *Elephas planifrons* in the Chagny sands at Bellecroix, near Chagny (Saône-et-Loire). This species has not, up to the present, been identified amongst the Pliocene elephants of Western Europe.—G. **Zeil**: Tectonic earthquakes and variations of latitude.—O. **Mengel**: Tectonic of the secondary synclinal of Amélie-les-Bains.—H. **Colin**: Crystallisable sugar and free acids in plants.—R. **Anthony** and J. **Liouville**: The characters of adaptation of the kidney of Ross's seal (*Ommatophoca Rossi*) to the conditions of aquatic life. The kidney of this seal presents the maximum of characters of specialisation, with respect to its aquatic life, met with amongst Pinnipeds. It is comparable with the kidney of Cetaceans of a primitive type, such as Mesoplodon.—L. M. **Bétancès**: The existence of thrombocytes in *Astacus fluviatilis*.—C. **Gessard**: A pyocyanic culture.—J. **Danysz** and Mme. St. **Danysz**: Attenuation of the pathogenic effects of certain micro-organisms by mixture with dead organisms of the same race.—M. **Fouassier**: The micro-organisms persisting in milk after pasteurisation: their *rôle* in the decomposition of hydrogen peroxide.

SYDNEY.

Linnean Society of New South Wales, June 14.—Mr. J. J. Fletcher, president, in the chair.—A special general meeting "in commemoration of the centenary of the birth of Sir William Macleay." The meeting was devoted to the presidential address, "The Society's Heritage from the Macleays," followed by an exhibit of mementoes of the Macleays. The many claims which the memory of Sir William Macleay has on the members of the society were recalled; details of the development of their interest in science of the direct line of the family, and the history of the Macleay collections up to 1874, were given. The mementoes exhibited consisted of portraits and copies of books and drawings of zoological interest, most of which had been presented to members of the Macleay family by their authors. Later, Prof. J. T. Wilson unveiled the society's Honour Roll, on which are inscribed the names of members who served abroad during the Great War.

June 30.—Mr. J. J. Fletcher, president, in the chair.—H. J. **Carter**: Notes on some Australian Tenebrionidæ, with descriptions of new species; also of a new genus and species of Buprestidæ. Thirty-three species of Tenebrionidæ belonging to eighteen genera (of which one is proposed as new) are described as new. As a result of the comparison by Mr. K. G. Blair of specimens with the types in the British Museum, a number of mistaken identifications are corrected and further synonymy is suggested. A re-examination of the species of the closely allied genera Dædrosis, Licinoma, Brycopia, and their allies has led to considerable modifications of tabulations previously published.—G. H. Hardy: The male genitalia of some robber-flies belonging to the sub-family Asilinæ (Diptera). The results of a study of a number of species of Australian robber-flies belonging to the subgenus Asilus indicate that the male genitalia afford a satisfactory basis for identifying the species. Eleven species (of which one is described as new) are dealt with and their male genitalia figured.

Books Received.

A Kinetic Theory of Gases and Liquids. By Prof. R. D. Kleeman. Pp. xvi+272. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 16*s*. 6*d*. net.

Electric Furnaces in the Iron and Steel Industry. By W. Rodenhauser, J. Schoenawa, and C. H. Von Baur. Translated and completely rewritten. Third edition, revised. Pp. xxi+460. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 24*s*. net.

Elementary Applied Mathematics: A Practical Course for General Students. By Prof. W. P. Webber. Pp. ix+115. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 7*s*. 6*d*. net.

Elementary Algebra. By C. V. Durell and G. W. Palmer. Part i. With Answers. Pp. xxxi+256+xlvi. (London: G. Bell and Sons, Ltd.) 4*s*. 6*d*.

Vaccination in the Tropics. By Col. W. G. King. Pp. 64. (London: Tropical Diseases Bureau.) 5*s*. net.

Das Schmerzproblem. By Prof. A. Goldscheider. Pp. iv+91. (Berlin: J. Springer.) 10 marks.

Elementary Practical Biochemistry. By Prof. W. A. Osborne. Pp. v+184. (Melbourne: W. Ramsay.)

Stones and Quarries. By J. A. Howe. Pp. x+137. (London: Sir I. Pitman and Sons, Ltd.) 3*s*. net.

Modern Explosives. By S. I. Levy. Pp. ix+109. (London: Sir I. Pitman and Sons, Ltd.) 3*s*. net.

Life in a Sussex Windmill. By E. A. Martin. Pp. v+118. (London: Allen and Donaldson, Ltd.) 6*s*. net.

The Elements of Practical Psycho-Analysis. By P. Bousfield. Pp. xii+276. (London: Kegan Paul and Co., Ltd.) 10*s*. 6*d*. net.

Catalysis and its Industrial Applications. By E. Jobling. Second edition. Pp. viii+144. (London: J. and A. Churchill.) 7*s*. 6*d*. net.

The Outline of History. By H. G. Wells. Revised and corrected edition. Pp. xx+652. (London: Cassell and Co., Ltd.) 21*s*. net.

The Victoria History of the Counties of England. A History of the County of Bedford. Part i., Geology, by J. Hopkinson and J. Saunders; Palæontology, by R. Lydekker, pp. 35, 3*s*. 6*d*. net. Parts iv. and vi., Early Man, by W. G. Smith; Anglo-Saxon Remains, by R. A. Smith, pp. 145–90, 5*s*. net. (London: Constable and Co., Ltd.)

Human Psychology. By Prof. H. C. Warren. Pp. xx+460. (London: Constable and Co., Ltd.) 12*s*. net.

George Stephenson. By Ruth Maxwell. Pp. 192. (London: G. G. Harrap and Co., Ltd.) 3*s*. 6*d*. net.

Memoirs of the Geological Survey, Scotland. The Mesozoic Rocks of Applecross, Raasay, and North-East Skye. By Dr. G. W. Lee. Pp. vii+93+plates. (Southampton: Ordnance Survey Office; Edinburgh: H.M. Stationery Office.) 6*s*. net.

Report on Compulsory Adoption of the Metric System in the United Kingdom. Pp. 70. (London: Conjoint Board of Scientific Societies.) 1*s*.

American Civil Engineers' Handbook. Edited by M. Merriman. Fourth edition, revised and enlarged. Pp. 1955. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 33*s*. net.

Topographic Maps and Sketch Mapping. By Prof. J. K. Finch. Pp. xi+175. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 13*s*. 6*d*. net.

The Control of Parenthood. By Prof. J. A. Thomson and others. Pp. xi+203. (London and New York: G. P. Putnam's Sons.) 7*s*. 6*d*. net.

An Introduction to Combinatory Analysis. By Major P. A. MacMahon. Pp. viii+71. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

The Influence of Man on Animal Life in Scotland: A Study in Faunal Evolution. By Dr. J. Ritchie. Pp. xvi+550. (Cambridge: At the University Press.) 28*s*. net.

Exercises from Elementary Algebra. By C. Godfrey and A. W. Siddons. Vols. i. and ii. complete. With Answers. Pp. x+395. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Small Holding and Irrigation: The New Form of Settlement in Palestine. By Dr. S. E. Soskin. Pp. 63. (London: G. Allen and Unwin, Ltd.) 2*s*. net.

CONTENTS.