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The Preservation of Food by Freezing.

CONSERVATION of our sources of energy is essential to national welfare, and the foodstuffs whence human energy is derived are not the least important of our "fuels." Quite casual enquiry is sufficient to show that serious wastage of food constantly occurs. Markets are at times unable to absorb gluts of fish or fruit for which no cold-storage accommodation is available, and large quantities of these foods are consequently lost, while in the successive stages of transit from the abattoir abroad to the retailer at home, infection by putrefactive bacteria accounts for the loss of an appreciable proportion of our meat supplies. Such losses can be minimised by the development of the methods of cold storage and by a thorough scientific understanding of all that is involved in the refrigeration industry. This industry is now an essential characteristic of life in crowded communities; its expansion during the past forty years, enabling the supply of food to keep pace with the needs of a growing population, has been a remarkable achievement. The importance of the industry is magnified in the case of an island community, such as our own, whose supplies of home-grown food are strictly limited. In an industry of this importance a scientific stocktaking cannot fail to give valuable results.

The refrigeration industry makes wide demands upon the sciences. It calls for the co-operation of physicist, engineer, physiologist, chemist, botanist, zoologist, and mathematician for the solution of its problems. In arranging, through the Food Investigation Board, a joint attack upon the problems of food preservation from these different points of view, the Department of Scientific and Industrial Research is undertaking a most important function. To meet the needs a comprehensive organisation is necessary—if only to visualise the field for research—and since those needs are of vital national importance, it is fitting that the organisation should be initiated and supported by Government.

There has long been lacking a summary of our knowledge concerning the scientific aspects of cold storage, but it has now been supplied by Prof. Walter Stiles, who, at the request of the Food Investigation Board, has prepared a report upon the preservation of food by freezing.[1] We believe that this is the first general systematic study in this country of the scientific principles underlying the preservation of food in the frozen condition. For much of the information which follows we are indebted to Prof. Stiles's report.

[1] "The Preservation of Food by Freezing with Special Reference to Fish and Meat," by Walter Stiles, Special Report No. 7 of the Food Investigation Board. Published by H.M. Stationery Office, 1922, price 10*s.* net.

Of the two refrigerative processes—chilling and freezing—employed for the preservation of food, the former is much inferior. In this process the temperature is kept at about 0° C., the physical state of the fresh material being maintained unchanged. In the freezing process, on the other hand, the temperature of storage is kept well below the freezing point of the food substance, which consequently becomes frozen into a solid block, the physical condition being profoundly changed. When it is remembered that, as a rough approximation, the velocity of a chemical reaction is halved by a fall of 10° C., it will be seen that the chilling process affords greater scope for the progress of the reactions incidental to putrefaction than does the freezing process. Moreover, the solid state of frozen tissue inhibits, or greatly reduces, the growth of micro-organisms and practically puts a stop to such putrefactive chemical actions as take place in aqueous media. While all foods can be preserved for a certain time by the chilling process, comparatively few are at the present time preserved by the freezing process. As Prof. Stiles points out, one of the objects of scientific investigation should be the transference of as many foods as possible from the chilling to the freezing process; and this was the object of many of the experiments of the Food Investigation Board which he describes. His report is restricted to the discussion of the processes and problems involved in the preservation of food in the frozen state. This method of preservation involves freezing, storage in the frozen state, and finally thawing of the frozen material, and the more nearly the condition of the foodstuff so treated resembles the original, the more successful has the storage been from the economic as well as the physiological standpoint.

In the freezing of foods the time of cooling is an all-important matter. It depends upon a number of factors, each of which Prof. Stiles examines in detail and indicates, by reference to the principles of physical chemistry, the extent to which they are controllable in the refrigeration industry. In foodstuffs other than liquids we are dealing with delicate and complex physical systems. True aqueous solutions of organic and inorganic substances and colloidal systems comprising both hydrosols and hydrogels are enmeshed in, or otherwise associated with, more or less definitely solid materials. Foodstuffs comprising such systems are obviously most susceptible to changing physical conditions, and it is only by careful study and control of the latter that successful food preservation can be ensured. The report directs attention to the gaps in our knowledge of matters of fundamental importance in refrigeration, such as, for example, the effect of rate of cooling upon the nature of sols and gels; in some cases the gaps have recently been filled by the work of Prof. Stiles and his collaborators. Thus he has made the interesting observation that, when rapidly frozen, a chlorophyll hydrosol is reversible; when slowly frozen the hydrosol yields visible "flocks" of chlorophyll, and the sol is not re-formed on thawing. Similarly he finds that the reversibility of the changes taking place in certain gels on freezing is largely dependent upon the rate of cooling, a gel which is rapidly cooled being reversible. Rapid cooling produces a fine-grained frozen mass, and, if this is sufficiently finely grained, the original structure of the sol or gel is restored on thawing. The statement may be extended to the freezing of plant and animal cells and tissues; such information as we have all indicates that, if these be frozen sufficiently rapidly, the changes in structure following freezing are reversed in thawing.

The essential importance of the vitamins for animal nutrition has made it necessary to ascertain the influence of low temperatures upon these accessory food substances. If the influence is markedly destructive, the nutritive value of foods must be seriously depreciated by cold storage. There is very little evidence upon this point at present, but it has been shown by Prof. A. Harden that the vitamin content of butter is undiminished by preservation in this way; investigations of the effect of low temperatures upon the antiscorbutic vitamins are at present in progress. Perhaps of little less importance than the vitamins are the enzymes in foodstuffs. Here more information is to hand. Generally speaking, enzymes survive exposure to the temperatures employed in refrigeration, and can exercise their catalytic functions when temperature and environment again become normal; in some cases, indeed, the catalytic activity may be increased by exposure to low temperatures.

Practically there are only two general methods employed in the freezing of foods on the large scale. These involve freezing in cold air, and in a cold brine solution, respectively.

Prof. Stiles's report includes a comparative account of the principles utilised in these processes. Air cooling is effected either by means of a system of cooling pipes placed inside the refrigerating chamber or by blowing into the chamber air which has been cooled outside by passage over a similar cooling-pipe system. Each method has obvious advantages and disadvantages, and the choice in any particular case will depend upon whether it is more important to reduce desiccation to a minimum or to avoid growth of micro-organisms. Fish depreciates rapidly by desiccation, but is not very liable to attack by micro-organisms; meat, on the other hand, does not lose water readily, but favours the growth of moulds.

The freezing of foodstuffs in salt solutions is a process still in the experimental stage, although a description of it is to be found in the British patent specification of Hesketh and Marcet of 1899. The advantage of the method over that of air freezing lies in the much more rapid cooling that results, and rapid cooling, as mentioned above, is a characteristic of the most successful refrigeration. Brine is the only salt solution employed in present practice, but other salts, such as magnesium or calcium chloride, might conceivably be used. The process of brine freezing has its inherent difficulties; not only may the food cell contents pass outwards into the cooling medium, but salt may also pass from the latter into the tissues of the food. Penetration of salt into the food material is in some cases (*i.e.* fish) not objectionable, but in certain instances chemical action may occur between the foodstuff and the salt with undesirable consequences. Thus, while large pieces of beef frozen in brine were found to be in some respects superior to air-frozen beef, a reaction takes place between the salt and the pigment of the beef which so changes the appearance of the latter that its market value may be considerably reduced. The penetration of salt into the food substance cannot be prevented, but it can be minimised by a judicious selection of physical conditions.

The methods adopted for the storage of frozen food require the same careful consideration as those employed for freezing; the inherent difficulties are just as great. Physical changes, such as evaporation of water and aromatic flavouring substances, chemical changes including autolytic reactions, hydrolysis of fats and oxidation of the hydrolytic products, and finally the growth of moulds and bacteria, must be guarded against. All these changes can be retarded by lowering the temperature of the storage chambers, but economic conditions impose a limit at which reduction of temperature must stop. It becomes, once more, a question of selecting the least injurious conditions for each particular food; the conditions in storage chambers should, it may be emphasised, be different for different foods.

The use of liquid air on a large scale in the freezing and storage of food appears a remote possibility at the present time; but it is perhaps not entirely fanciful to picture a liquid air plant supplying nitrogen for use in the refrigeration industry and oxygen for other industrial purposes.

Prof. Stiles gives a brief summary of the available information concerning thawing of food. This side of the subject is not without importance, since the rate of thawing of frozen food has a significant effect upon its character.

A considerable proportion of the report is devoted to an examination of the relative merits of air freezing and freezing in salt solution in the case of both fish and of meat. The comparison, so far as the ultimate value of the food is concerned, is much in favour of the latter process. Parenthetically it may be added that Prof. Stiles does not deal with the economic side of the refrigeration industry. Despite its advantages and the fact that it has been known for a considerable time, the freezing of fish in a solution is a process which has only been employed during recent years, and on a small scale. Its chief advantages are the maintenance of weight, appearance, and general food value of the fish due to the reduced time of freezing and consequent minimised histological change. A quantity of experimental evidence obtained by the author and his co-workers under the Food Investigation Board, as well as by other workers in the subject, is collected in the report, and merits careful study by those who are concerned with the design and installation of food-preservation plant.

For the refrigeration of meat, freezing by immersion in brine has not yet been technically employed; the only process utilised is that of freezing in cold air. Beef which has been preserved in the frozen state is frequently inferior to fresh beef on account of the drip of meat juice which occurs on thawing. This loss may amount to as much as 15 per cent. of the weight of the meat. Consequently beef is, wherever possible, transported in the chilled condition; but since it cannot be kept in this state for more than three or four weeks, it is not possible to import chilled beef into the United Kingdom from Australia or New Zealand. From far distant countries beef must come "on the hoof" or in the frozen condition. Mutton, on the other hand, can be imported in the frozen state from the countries named in perfectly satisfactory condition. The discovery of a method of freezing beef which will obviate the difficulties mentioned is evidently a matter of importance, and the attempts made by the Food Investigation Board in this direction are of considerable interest. Small preliminary experiments indicated that rapid freezing by immersion in cold brine was an effective way of preservation so far as absence of drip, and appearance and flavour of the product after thawing were concerned. Larger-scale experiments have not yet gone sufficiently far to yield conclusive results. One rather serious objection has already been mentioned. This is the discoloration of the surface layers of the lean of the meat owing to the conversion of hæmoglobin into methæmoglobin. The discoloration detracts seriously from the appearance and market value of the meat, but it is hoped that the cause, and a method of prevention, will be discovered in the course of further work. The successful application to beef of the method of brine freezing would lead to a very desirable expansion of our source of supply.

The Victorian Age.

The Victorian Age: The Rede Lecture for 1922. By Dr. William Ralph Inge. Pp. 54. (Cambridge: At the University Press, 1922.) 2*s*. 6*d*. net.

IN choosing the Victorian Age as the subject of his Rede Lecture, Dean Inge afforded his audience ample occasion in which to enjoy the *obiter dicta,* which so frequently characterise his public utterances, and impart to them so piquant a flavour. It may be said the theme itself provided its opportunities. Its possibilities, in fact, of observations *en passant,* without a too obvious breach of continuity, are well-nigh limitless. The learned lecturer evidently revelled in the wealth and suggestiveness of his material, and the epigrams and aphorisms, at times, are almost coruscant in their brilliancy. Not that we would for a moment imply that the Dean's prelection in any way resembles the sermon of which King James remarked "that the tropes and metaphors of the speaker were like the brilliant wild flowers in a field of corn, very pretty, but which did very much hurt the corn." The richness of the soil which the Dean undertook to cultivate ensured the wealth and vigour of his crop; his flowers do but enhance the beauty of the field.

It may, however, be questioned whether the Dean's *obiter dicta* are always as sound as they are brilliant. For example, it is by no means invariably true that the pioneer starts by being unintelligible or absurd, has then a brief spell of popularity, and ends by being conventional and antiquated. The general character of the Civil Service in 1837 no doubt left much to be desired, but it is a travesty to say that it was "a sanctuary of aristocratic jobbery," and that its clerks were languid gentlemen with long whiskers, who, like Charles Lamb, departed early from their offices because they arrived late. The Dean occasionally is in danger of risking his credit for veracity by his irrepressible lore of paradox and his affection for the epigram's peculiar grace, and for

"Some unexpected and some biting thought
With poignant wit and sharp expression fraught."

If, however, we make due allowance for the characteristic foibles of the lecturer, the Dean's brilliant survey of the significant features of the time covered by the reign of Queen Victoria is both illuminating and instructive. As he truly says, that period extended over the latter half of a *saeculum mirabile,* the most wonderful century in human history. His word-picture of England before what Toynbee styled the Industrial Revolution, is done in his most characteristic manner. The country then, we are told, was, on the whole, prosperous and contented. "The masses had no voice in the government, but most of them had a stake in the country. . . . Political power was in the hands of a genuine aristocracy, who did more to deserve their privileges than any other aristocracy of modern times. . . . They were enlightened patrons of literature and art, and made the collections of masterpieces which were the pride of England and which are now being dispersed to the winds. . . . Those who have studied the family portraits in a great house, or the wonderful portrait gallery in the Provost's Lodge at Eton, will see on the faces not only the pride and self-satisfaction of a privileged class, but the power to lead the nation, whether in the arts of war or of peace"—a picture, in short, which will bring solace to the shade of that "Great Cham of Literature," the immortal Dr. Samuel Johnson. Not that the Dean can be truthfully described as a *laudator temporis acti,* for he is never wholly content with any age, and least of all with that in which he lives.

The whole account of the condition of England in the earlier years of the Victorian Age is tinctured with that flavour of mordant pessimism in which the Dean delights, and practically every phase and institution of the period comes under the gentle lash of his tolerant satire—its literature of complacency, the Platonism of Ruskin, the vehemence of Carlyle, the ugliness of the modern English or American town ("Never since civilisation began has such ugliness been created"); the gigantic blunder of the Industrial Revolution; the problem of mending or ending industrialism, foolishly called capitalism. ("Ruskin's own artistic life would have been impossible without the paternal sherry and the rich men who drank it; and Morris's exquisite manufactures depended absolutely on the patronage of the capitalists whom he denounced.") Departmental inefficiency; the systems of judicature; the slow emergence of the universities from the lethargy of the eighteenth century, "when they neither taught nor examined nor maintained discipline," when the Fellows "were most of them waiting for college livings, to which they were allowed to carry off, as a solatium, some dozens of College port"; the state of the army, "when a Royal Duke could not be given a military funeral, because there were not troops enough to bury a Field Marshal"; its glaring incompetence as revealed by the Crimean War, etc.

But the age had its compensations. The Dean is constrained to admit with Lecky that, at least so far as internal affairs went, no country was ever better governed than England between 1832 and 1867. "The one prime necessity for good government was present; those who paid the taxes were also those who imposed them. . . . Sound finance benefited the whole population by keeping credit high, interest low, and taxation light. Political life was purer than it had been, and purer probably than it is now. The House of Commons enjoyed that immense prestige which has been completely lost since the old Queen's death."

With regard to the intellectual and spiritual movements of her reign the Dean, if not exactly eulogistic, is at least more commendatory, and no part of his lecture affords more delightful reading, or exhibits sounder discrimination, than his account of the literary glories of the Victorian Age. As regards religion, he thinks it may be doubted whether organised Christianity has ever been more influential in England than during that period, "before the growth of the towns threw all the Church's machinery out of gear." At the same time, he admits that religious intolerance was very bitter, and only the secular arm stopped a whole series of ecclesiastical prosecutions. "Real hatred was shown against the scientific leaders, which Darwin calmly ignored, and Huxley returned with interest."

In parting with his subject the Dean, as might be anticipated, strikes no jubilant note. To him the Elizabethan and the Victorian Age appear as the twin peaks of English civilisation. But, he concludes, "as regards the fortunes of this country, the signs are that our work on a grand scale, with the whole world as our stage, is probably nearing its end." To which we can only fervently reply, *Absit omen.*

Natural History of Pheasants.

A Monograph of the Pheasants. By William Beebe. In four volumes. Volume III. Pp. xvi+204+pl. XLV-LXVIII+photogravure plates 40-60. (London: published under the auspices of the New York Zoological Society by H. F. and G. Witherby, 1922.) 12*l.* 10*s.* net.

THE third volume of this sumptuous work treats of the true pheasants—the genus Phasianus—and of the birds of the allied genera Puchrasia, Catreus, and Syrmaticus. Mr. Beebe has made an extensive study of the genus Phasianus, which embraces the most familiar and important birds dealt with in the monograph. His conclusions, based upon an exhaustive examination of numerous specimens, and his unique knowledge of the birds in their native haunts, are of outstanding importance.

In order to treat clearly of the group, Mr. Beebe has drawn a sharp line of demarcation between Phasiani as they exist in their real zone of distribution, and the forms which have been crossed indiscriminately and acclimatised in all parts of the world. At least thirty-five forms have been described as species, or sub-species, or geographical races, according to the personal bias of authors; but in the evolution of these forms, mutation appears to have played little part, for most of them actually grade into one another, and even in their extremes are separated only by slight differences of colour and pattern. A good deal of individual variation occurs, especially in the more widely distributed forms, and this necessitates changing the status of species in this genus. The genus has usually included more forms than those recognised by the author, who, by consistently applying his criterion of genera—that of geographic non-overlapping—has removed the birds of the genera Syrmaticus and Calophasis from Phasianus, which is thus left "as an exceedingly homogeneous group."

In addition to a careful comparison of the numerous types and study of their environment, distribution, and barriers, Mr. Beebe has devoted much attention to the classification of the birds of this genus. Two very different lines of observation have contributed much to his ultimate decision. First, the results of a single day's collecting in China revealed, out of four brace of fully adult birds in freshly moulted plumage, several belonging to one covey, three recognisable sub-species, and two undescribed ones were obtained in two moderate-sized rice-fields. The second array of facts is derived from the conditions found among semi-wild hybrids introduced into foreign countries. Thus, at Tring, pheasants of colchicus, torquatus, and even of versicolor blood were turned down. Later a strain of pallasi was introduced, and from this mixture there arose pheasants which were absolutely indistinguishable from the wild form known as satscheuensis, the home of which is in the heart of China. From scores of similar facts Mr. Beebe has decided to consider every one of the continental forms of Phasianus as sub-species of *Phasianus colchicus.* The Japanese pheasant (*P. versicolor*) stands the test of a good species and is the most distinct of all the Phasianus group.

The distribution of the wild members of the colchicus group extends across Asia, from the Sea of Azof and the Black Sea eastwards to the Sea of Japan—a distance of nearly 5000 miles—and from Manchuria in the north to beyond the Tropic of Cancer. Throughout this wide area they have penetrated into valleys or along mountain slopes, sweeping through passes and adapting themselves to semi-arid deserts.

The typical form of the entire group, the common pheasant, the "Rion Caucasian Pheasant" of the monograph, is a native of Caucasia, and is said to have been introduced into Europe from the banks of the River Phasis (now the Rion) in Colchis (now Kurtais). Though not mentioned by Mr. Beebe, the remains of Phasianus have been found in the Miocene of France and Switzerland, in the Pliocene of Greece, and in the Pleistocene of Germany—hence pheasants, possibly forms of colchicus, existed in Europe long before the advent of man.

With regard to the Koklass pheasants — genus Puchrasia—Mr. Beebe alludes to the difficulty of placing them with certainty in any linear scheme of classification. They show traces of resemblance to several groups, and perhaps come as close to the genus Syrmaticus, as defined by him, as to any other. The genus is one of the most interesting of the Phasianinæ, and its various forms reveal one of the rarest phenomena in nature—a widespread series showing delicately graduated and increasing complexity within a single closely related group of living creatures. Three species are recognised—*P. macrolopha*, *P. xanthospila*, and *P. darwini*, each with several forms.

The genus Syrmaticus, previous to Mr. Beebe's researches, contained a single species only—the gorgeous long-tailed Reeves pheasant, but here it has been expanded to include four additional species, namely, the copper pheasant, *S. soemmerringi*, comprising three forms ; Hume's pheasants, *S. humiæ*, with two forms ; Elliot's pheasant, *S. ellioti* ; and the Mikado pheasant, *S. mikado*.

The Cheer pheasant (*C. wallichii*) exhibits a number of characters sufficiently distinct to warrant its inclusion in a separate genus, *Catreus*. It is confined to a comparatively small belt in the west and central Himalayas—Kumaon, Garhwal, and western Nepal—where it is found at elevations of 4000-10,000 feet.

In addition to the author's masterly treatment of the taxonomic aspect of the subject, he has added a charm to it by his graphic descriptions of the haunts and habits of the various birds which came under notice during his remarkable journeys, undertaken for observing and procuring specimens in various stages of plumage. He has also quoted copiously, when desirable, from the experiences of others. This combination of excellence, if it has ever been equalled, has never been surpassed in such a monograph.

The coloured plates, twenty-four in number, are reproductions from original drawings. Of these eleven are devoted to the principal forms of the true pheasants, and are from very careful drawings by the late Major Jones. The rest are the work of several well-known artists, among them Mr. G. E. Lodge, Mr. Fuertes, and Mr. Grönvold, but their reproduction is not so satisfactory as those which graced the preceding volumes. There are twenty-one photogravure plates depicting the haunts amid which the various forms are found and some of their nests. These are mainly from photographs by Mr. Beebe, and add much to the attractiveness of the volume. The maps delineating the distribution of all the forms treated of are a very useful adjunct.

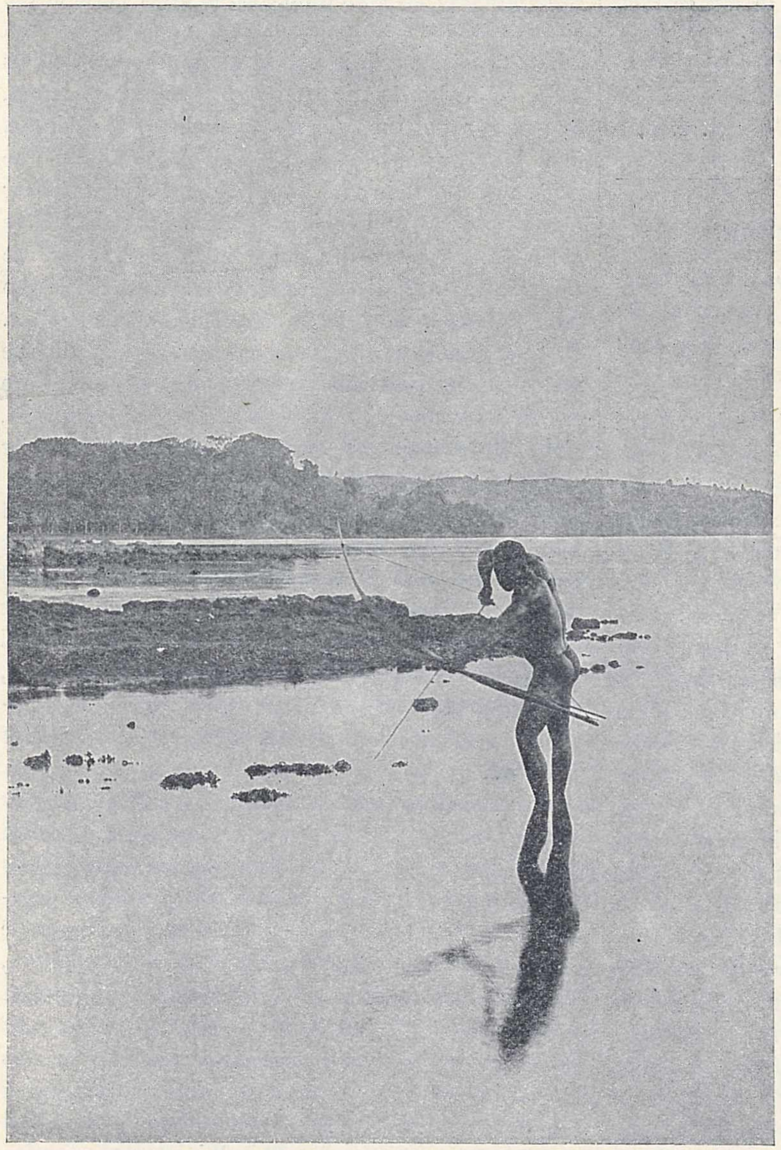
W. E. C.

A New Book on the Andamans.

The Andaman Islanders: A Study in Social Anthropology. (Anthony Wilkin Studentship Research, 1906.) By A. R. Brown. Pp. xiv + 504 + 20 plates + 2 maps. (Cambridge: At the University Press, 1922.) 40*s*. net.

THIS handsome volume contains the anthropological results of a short residence of about eighteen months in the Andaman Islands on behalf of the "Anthony Wilkin Students' Research," and may therefore be taken as a sample of approved work by the modern type of Cambridge-trained student. It is well produced by the Cambridge University Press, and is excellently illustrated from photographs taken, it is presumed, by the author. Indeed, so good are these last that the present writer recognises the originals of several of the portraits. As regards photographs illustrating these aborigines, their surroundings, habits, manners, and customs, the scientific world is specially well off, owing to the efforts extended over many years by such competent illustrators as Messrs. E. H. Man and M. V. Portman, the many magnificent volumes of the latter observer, deposited in the India Office Library, being not nearly so well known as they should be.

The book may be divided into two parts: a running account of Mr. A. R. Brown's travels, giving the results of his observations of facts, together with references to and criticisms of his predecessors in this particular field of research, chiefly of Mr. E. H. Man, and an "interpretation" of the observations. The plan of the book is thus a good one. The writer states his own observations and where he differs from his predecessors, and then builds his theories on the results. It is where he ventures to differ from Mr. Man that the plan seems to fail to be as effective as it ought to be. He constantly sets up Mr. Man's views and statements only to knock them down. He thus pits his opinions against Mr. Man's. This makes for comparison, and leads to the observation that Mr. Man was thirty years with the Andamanese, knew them intimately and their language well, and studied them unremittingly: all this, too, at a time when they were numerous, their tribes well separable from each other, and the contact with Europeans comparatively recent. Whereas Mr. Brown was with them for a short time, depended on interpreters, did not know the language except superficially, and only met them after they had been so decimated by epidemics that the tribes had had to drop their old exclusiveness and mingle freely together. It is true that Mr. Man was a pioneer who had to learn his way, and that Mr. Brown was a trained observer from the beginning, but all who know Mr. Man's work cannot also help knowing how meticulously and conscientiously careful he is in recording an observation of fact. It requires some boldness to differ from him on the point of accuracy. Several observers have tried, and not successfully. The result is that this latest book on the Andamanese after all contains only evidence and not judgment. Mr. Brown is, here, nothing more than a witness—a good witness certainly, trained to his work—but only a witness, and the reader will have to decide for himself between him and Mr. Man.



An Andaman Islander shooting fish in Port Blair Harbour. From " The Andaman Islanders."

In the matter of recording language Mr. Brown has not been fortunate, though he has laboured hard. The older books and articles, from Mr. Man's works onwards, used an alphabet framed *ad hoc* by no less an authority than the late Mr. A. J. Ellis, whose skill, knowledge, and experience in such matters are still difficult to beat. The result has been that a good trustworthy system for recording these " unwritten " dialects for English readers has been in vogue for something like half a century. Mr. Brown has discarded it, and substituted the " Anthropos " Alphabet of Pater Schmidt. No one disputes the capacity of Pater Schmidt in this matter, but why in a book by an Englishman for English readers, published by an English University, go to an Austrian for the transcription of the language of the inhabitants of a British possession, when an adequate and well-known English transcription has been established for a long period, and has been used in many books ? At any rate the result is not happy. Diacritical marks are used which are strange to English readers, though common enough in the Eastern European languages. The vowels are not familiar to users of English, and what are we to say of an observer who cannot detect the difference between " the *e* in error " and " *a* in Mary," and thinks they represent the same sound (p. 496). Or between the " *o* in not " and the " *o* in nought " (p. 496). Unhappily for Mr. Brown all four sounds are common in Andamanese, and he has thus put himself out of court as a recorder of languages, much more so as a critic of other people's work in this respect.

Like so many of his Oxford and Cambridge contemporaries, Mr. Brown reverts too often to a bad habit of the seventeenth-century writers on travel and foreign countries in ignoring the bibliography of his subject—in this case a long one—except to appropriate without acknowledgment the information gathered, often laboriously, by even living predecessors. There are too many clear instances of this in his book.

Despite its drawbacks, however, the book supplies much good evidence on its subject, and the student will do well to make its acquaintance. With the second part one is not inclined to quarrel. It propounds a theory which cannot be gone into in a short review; but whether a theory stands criticism or not as time goes on, it is a good thing to put it forward, as the mere dissection of it promotes research and the acquisition of knowledge resulting from the research.

R. C. T.

Hydro-Electric Engineering.

Hydro-Electric Engineering. Vol. 1, *Civil and Mechanical.* Editor: Dr. A. H. Gibson. Contributors: H. D. Cook and the Editor. Pp. x+232. (London: Blackie and Son, Ltd., 1921.) 25*s.* net.

THE water resources of the world, from the point of view of available power for domestic, industrial, and agricultural uses, have received very considerable attention in recent years, and in many countries a large amount of information has been accumulated as to the amount of water-power that is available for exploitation. Not only have various sources of power, such as those of the great waterfalls, been harnessed, but in addition many schemes for impounding waters in suitable valleys and utilising them for power generation, irrigation, and for distribution to cities many miles distant have been carried into effect and at the present time many more are receiving serious consideration. In this country much has been done to impound waters for town and city purposes, but comparatively little has been attempted to develop the water-power available. Until the war came, with all its consequent economic problems, not least of which is the very serious increase in the price of coal, power could be produced by steam-engines and internal combustion engines at a price which made it practically impossible for water-power to compete, involving as it does large capital outlays per unit power produced and cost of transit over long distances. It is perhaps not surprising, therefore, that although Fairbairn and James Thompson in the British Isles were largely responsible for the very important developments which took place in water wheels and turbines in the nineteenth century, and the correct principles of design were very largely developed here and in France, yet neither of these countries have developed water-power as have, for example, Switzerland, Norway, and the United States. Students in Great Britain have not been encouraged to take a very keen interest in the subject and the literature published in this country has been somewhat scanty.

Recently, however, the Water Resources Committee, which has issued a number of reports, has investigated the power available in Great Britain, and a good deal of interest has been aroused in the possibilities of the development of hydro-electric power schemes. An equal interest has been awakened in other parts of the empire where the power available is much greater than here and where coal is not so easily obtained. This work on hydro-electric engineering comes, therefore, at an opportune time, for it is desirable that engineers and business men should understand clearly the principles underlying the storage and use of water for power purposes, and engineering students should have available a trustworthy guide in the study of the subject. A word of warning is required to those who hope to take a short cut to knowledge of the subject. In few branches of engineering have such diverse matters to be dealt with, and thus only those who are prepared by a sound training in engineering principles, civil, mechanical, and electrical, can appreciate fully and overcome the difficulties.

In the work before us, the authors have discussed some of the important principles involved but a great part of the work is occupied with descriptions and details of actual works. The all-important subject of the relationship of the water available to the rainfall on a given watershed, the power that can be obtained, and the problem of the flow of water and its measurement receive adequate treatment in the first third of the book.

The remaining portion of the book deals entirely with turbines. The various types are described with the aid of drawings of actual turbines, and the principles of design are discussed. It is of the greatest importance that the behaviour of turbines under variable conditions of gate opening and speed should be known, and typical characteristic curves are given for reaction turbines in which unit power is plotted against unit speed for various gate openings. Efficiency curves are also shown for turbines working under varying conditions of load. The Pelton Wheel is described and the theory discussed. The all-important question of the choice of the most suitable type of turbine for particular conditions is somewhat briefly referred to but the essential points to be considered are clearly presented.

An important chapter is devoted to speed regulation, and hydraulic problems connected with any attempt to change suddenly the flow of a large volume of water, and the theory of the surge tank are clearly discussed. Johnson's approximate formula for the movement of the water in a large tank for a given change of velocity in the pipe is also obtained. The danger of the period of oscillation in the tank synchronising with the governor is pointed out, and Johnson's differential surge tank, introduced to overcome this difficulty, is described. The concluding chapters deal with the general arrangement of stations and water-power reports. The text is clearly written and the illustrations are very good.

F. C. L.

Progress in Fat and Oil Chemistry.

Chemical Technology and Analysis of Oils, Fats and Waxes. By Dr. J. Lewkowitsch. Sixth edition, entirely revised by G. H. Warburton. Vol. 1. Pp. xviii + 682. Vol. 2. Pp. xii + 959. (London: Macmillan and Co., Ltd., 1922). 36*s*. and 42*s*. net.

THE successive editions of Lewkowitsch's "Oils and Fats"—now carried on by his successor, Mr. G. H. Warburton—are regarded almost as milestones by those engaged, in whatever capacity, in the industries based on these products, and their appearance affords a fitting moment for taking stock. It is perhaps of interest that the third edition was noticed in NATURE of September 22, 1904, p. 502, the fourth in the issue for August 19, 1909, p. 211, and the fifth in the issue for December 18, 1913, p. 449. The book is now of such size that this—the sixth edition—is like its predecessor, divided into three volumes of which only the first two have so far appeared. The index, unfortunately for the reader and the reviewer, is confined to the third volume, so that reference to these volumes is far from easy. We would strongly urge that this defect in so valuable a work be rectified in the future, as the temporary use of the first two volumes is impaired, and the reader in the future has to go to the labour of consulting two heavy volumes for the desired information.

Volume 1 as heretofore is devoted to the chemistry and analysis of the fats, a side which during the last decade has been relatively neglected. Volume 2, after an all too brief introductory section devoted to the obtaining of oils by the various methods of practice, deals in detail with the properties of the several oils. Volume 1 is described on the title page as entirely rewritten and enlarged, and volume 2, more circumspectly, as entirely revised. Both volumes, however, would be more properly described as revised, as little more has been done than to bring them up-to-date by the addition of new matter. No doubt in the remaining volume, which deals with a section of the subject in which very great progress has been made largely as the result of the altered conditions brought about by the war, much will have to be rewritten, but it is scarcely correct to apply this phrase to these volumes. From this point of view the new edition is frankly a disappointment: opportunity might have been taken to prune much which was diffuse and indefinite, and really to keep the work up-to-date in a crisp form. As it is, the reader at all versed in the subject will more often than not experience disappointment on consulting it, while for those who have the former edition the expenditure of a somewhat large sum on the new issue cannot be justified.

It is to be regretted that the study of the chemistry of fats and allied compounds is not at present fashionable amongst schools of chemical research, possibly in part because of the difficulty of the subject and the need to tackle it by what may be termed team work before results can be obtained. However this may be, the field of research is full of the most interesting possibilities both in the domain of pure organic, of physical and of biological chemistry. We may cite the work of Hardy, Adam, Langmuir, and others in this connexion, and the pioneer work on the synthesis of mixed glycerides commenced by Emil Fischer just before his death, with the hope that some of our workers will once more be attracted into this field of inquiry. Analytical work such as is embodied in volume 2 of the book is of interest technically, but the number of oils of prime industrial importance is limited to those which can be produced in quantity, and with sufficient regularity to make it an economical proposition to instal the requisite machinery to deal with them. Consequently, but few of the newer oils described become of practical interest: the world shortage of oils and fats so confidently predicted by the expert a few years ago has failed to materialise, so that there is no demand for new oils; indeed, to-day most of the vegetable oils are being marketed at prices unremunerative to the grower and manufacturer.

What is mainly wanted at the present time is far greater attention to quality: in this connexion it should be emphasised how little is known as to the manner of production of oils in plants, and the supposed change in the proportion of saturated to unsaturated acids in the oil during the ripening of the seed; also the cause of the development of fatty acid in the oil and its increase during storage. There is an opportunity for much research on the part of the biochemist in this direction.

The structure of a long open chain organic compound and the points of weakness at which it is most susceptible to attack is a question of prime interest to the chemist. The close packing hypothesis of Pope and Barlow, the modern crystal structure theory of the Braggs, and the recurrent spiral structure resembling a drawn-out coil of wire attributed to it of others, all have their adherents, and additional practical data are most desirable. The hydrocarbons themselves are unsuitable for this purpose, but the fatty acids with their crystalline derivatives afford much more desirable material for research.

While in no way depreciating the enormous amount of information contained in the book, which virtually makes it an exhaustive dictionary, it is permissible to suggest that from the point of view of the user, a much more careful selection and limitation of the material would be an advantage. E. F. A.

Our Bookshelf.

Die chemische Analyse. Herausgegeben von Dr. B. M. Margosches. VIII.-IX. Band: Methoden zur Untersuchung von Milch und Molkereiprodukten. Von Dr. Kurt Teichert. Pp. 374. (Stuttgart: F. Enke, 1909.) 11.40 marks (England: 45.60 marks).

ON account of the interest now being shown in the quality of our milk supply, attention may be usefully directed to this book. It deals exclusively with milk and dairy products and forms the eighth and ninth volume of the general treatise on chemical analysis. The greater part of the space is devoted to the standard methods of analysis, but there is in addition a large amount of information which ought to be of help to the analyst and medical officer of health.

A preliminary section deals with the composition and properties of milk and the factors which are responsible for any change in the normal composition. Following this comes the portion which is concerned with the detailed analytical methods for the determination of fat, milk sugar, protein, etc. The chapter on cleanliness of milk and its freedom from bacterial contamination puts the facts in a clear and convincing manner, and is very valuable in view of the recognition of the dangers of uncleanliness both from the standpoint of public health and the manufacture of such products as butter and cheese. In this connexion the employment of the reductase and catalase tests has not become so general as was at one time expected, although the direct determination of dirt is now a regular practice in all analytical and public health laboratories, and leads to the punishment of those who dispose of filthy and insanitary milk.

Purely bacteriological methods of examination are shown to be difficult, particularly when applied to the detection of pathogenic organisms. The fermentation test, which is easily and rapidly carried out, is now being used to a greater extent both in connexion with the public milk supply and the cheese factory.

The chapter on the adulteration of milk, and the interpretation of the results of analysis obtained in this connexion, is valuable, as is also the one on the testing of cream, skim milk, whey, condensed milk, etc.

As in the case of milk, so with butter and cheese there are given details of analytical methods and hints on the interpretation of results. The detection of adulteration by the addition of foreign fats is dealt with, and other sections are concerned with the analysis of materials used in the preparation of cheese.

The volume is one for reference and the details appear to be scientifically sound.

Aeroplane Performance Calculations. By Harris Booth. (The Directly-Useful Technical Series.) Pp. xv+207. (London: Chapman and Hall, Ltd., 1921.) 21*s*. net.

THE development of aviation appears to be entering on a new phase in which "safety in the air" is singled out as of primary present importance. This follows an era of military devotion to the cult of "performance," and the object of the book under review appears to be the statement of the detailed steps which have hitherto been taken to secure the greatest speed and maximum rate of climb of an aeroplane.

It is probable that the actual arithmetical processes described will rapidly fall out of use, but that the principles invoked will have a greater degree of permanence. The interest of the book is not so much in the relative merits of the four methods of prediction of aeroplane performance described in chapter II. as in the statement of the problem as it appears to a designer. Much of the book shows the individuality of the author, but the general outlook is typically that of the community of aeroplane designers.

It is perhaps desirable at this point to indicate the established position as to aeroplane design and its relation to performance. The data used by all are common—derived mainly from sources external to the aviation industry—and have been used with almost equal success by a number of designers. In the result it is found possible to predict the consequences of the best efforts from preliminary sketch designs. To realise completely the maximum performance, it is necessary for a designer to consider the details of his craft carefully, and Mr. Harris Booth's book shows how that may be done. Further, it illustrates an essential element of progress, for it assesses in numerical form the importance of separate items in the complete whole. In illustration of this point, it will be found that 14 lbs. is estimated to be the resistance of a flying-boat hull if the open cockpits and hydroplaning steps are excluded. A further estimate shows that the steps account for 52 lbs. at the same speed and each cockpit for a further 17 lbs. Here is a striking example of the fact that the very small resistance of a smooth streamline body may be increased five- or six-fold by departures required for various reasons.

It is just because of its indications of the need for care in design that the present volume may fairly be accorded a place on the shelves of an aeronautical or design office library. So far as can be judged its importance is limited to such function, since the writer is following common practice in supposing that "performance" does not include "safety."

Building Contracts: The Principles and Practice of their Administration. By Edwin J. Evans. (The Directly-Useful Technical Series.) Pp. xviii+304. (London: Chapman and Hall, Ltd., 1922.) 10*s*. 6*d*. net.

THE building trade resembles a good many others in that, while liberally supplied with works on the technical side, there is very little literature dealing with the business side. The present volume is intended to fill this gap. The subject matter is divided into four parts, namely, the administration of contracts, office management, book-keeping, and trade memoranda. A glance at the table of contents will prepare the reader for some interesting information regarding what goes on behind the scenes. For example, among "methods usually adopted by contractors to obtain business" we find the following which refers to work undertaken on a percentage basis :—"It is surprising how many commissions of this character are secured by some contractors, and often well proceeded with, before their competitors are aware that the work is in operation. It must therefore be obvious that a good portion of the time and energy of these enterprising contractors is spent by keeping in touch with and studying the wishes and the requirements of architects and others who have work to place. These contractors are usually most obliging and amiable gentlemen who see no trouble in doing anything which will bring about business." The author is equally candid in many other matters, and it is impossible to read his book without feeling that he is intimately in touch with all the ramifications of his subject. The volume is a mine of information on all matters connected with the execution of building contracts, and will be of great value both to contractors and students.

Handboek der Algemeene Erfelijkheidsleer. By Dr. M. J. Sirks. Pp. x+494. ('S-Gravenhage: M. Nijhoff, 1922.) 15 gld.

TEXT-BOOKS of genetics have lately appeared with great rapidity. The most recent is that by Dr. Sirks, now before us. It is a substantial and well-illustrated volume, as good as its predecessors, covering the ground which has been explored up to date. The weakness of the book is that it attempts nothing new, whether by way of presentation or analysis. In a subject so new as genetics, something more than an exposition of easily accessible records should be demanded from a considerable text-book. The literature of horticulture and of animal breeding contains abundant material, both illustrative of established principles and suggestive of extensions, which has not yet been drawn upon. An author need be at no loss for novel themes of discussion, even if he has no actual discovery to present.

Dr. Sirks shows a disposition to limit his survey to the publications of the modern period and to subjects which have acquired topical familiarity. His treatment, moreover, is occasionally uncritical. The reader should have been told more explicitly that some of the interpretations, given as accepted doctrine, are highly speculative, and that some of the statements of fact are greatly in need of verification. Reports, for example, of the production of mutations as a direct consequence of changed conditions should not be accepted without a warning that, until the experiments have been repeated on an ample scale and confirmation obtained, evidence of this class has only suggestive value.

Manchester University Roll of Service. Pp. xvi+274. (Manchester: At the University Press; London: Longmans, Green and Co., 1922.) 10s. net.

THE Roll of Service of the University of Manchester contains 3765 names, of which 500 are those who lost their lives on service during the war. In each of these latter cases a brief account is given of the career, including details of parentage, education, military history, distinctions, and particulars of death. In all, 842 distinctions were won, including two Victoria Crosses.

A preface to the volume has been written by the Vice-Chancellor, Sir Henry A. Miers. The record is very well arranged and produced, and serves as an adequate reminder of the service rendered by members of the University. It is also, to some extent, a memorial to those who laid down their lives in the common cause.

James Stirling: A Sketch of his Life and Works, along with his Scientific Correspondence. By Charles Tweedie. Pp. xii+213. (Oxford: Clarendon Press, 1922.) 16s. net.

MR. TWEEDIE's volume opens with an account of the life of James Stirling, the distinguished mathematician of the early eighteenth century. Next follows a description of Stirling's contributions to mathematical knowledge, chief among them being his enumeration of cubic curves and the *Methodus Differentialis*. This latter is a remarkable piece of analysis, considering the state of mathematical knowledge at the time when it was evolved; it leads to the well-known expansion for log $(n!)$ associated with Stirling's name. About three-quarters of the volume is occupied by copies of letters exchanged (during the period 1719-1740) between Stirling and such contemporary mathematicians as Maclaurin, Cramer, N. Bernoulli, Machin, Clairaut, and Euler. In days before scientific journals were developed new results were communicated by one worker to another in such letters as these. Much care has been expended by Mr. Tweedie in the reproduction of these letters: his book would have been improved by the addition of English translations of the French and Latin ones and by further comments upon them.

W. E. H. B.

Contemporary Science. Edited, with an Introduction, by W. B. Harrow. (The Modern Library of the World's Best Books.) Pp. 253. (New York: Boni and Liveright, 1921.) 95 cents net.

THE work under notice consists of a collection of twelve essays on recent achievements in various branches of science, by men who are masters in each. All are written in a way which makes them intelligible to readers whose special knowledge is not profound; yet even those who are engaged in advanced research may find interest in perusing them. This applies with special force to an excellent review of modern physics by Prof. Millikan. Though perhaps none the worse for the fact, the volume is a little unbalanced, articles of general importance being placed side by side with those dealing with such special topics as methods of gas warfare, the physiology of the aviator, and the measurement of brain-power. The inclusion of these is a reflection of the preoccupations of war time; and if their interest has waned, they serve to mark points in history. Atomic structure, engineering (Parsons), enzymes (Lister), duration of life, bacteriology (Flexner), psychoanalysis and Einstein, will serve as clues to the scope 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.*]

Cosmical Theory and Radioactivity.

SIR ERNEST RUTHERFORD in his book "Radioactive Substances and their Radiations" has suggested the possibility that solar heat may be supplied from radioactive energy derived from elements which had become radioactive under the extreme thermal conditions prevailing.

As possibly having bearings on cosmical theory (formation of nebulæ, planetary genesis, etc.) I would direct attention to the probability that such induced radioactivity would be attended with explosive phenomena on a very great scale and of extreme intensity.

Let it be assumed that in some deep-seated region of the sun the temperature has attained a potential critical for some element present—that is to say, adequate to disturb the atomic stability of this element. Now normal radioactivity results from internal atomic causes and the radioactive constant is statistical in origin, like a death-rate. But here instability is induced from without inwards. It seems, therefore, difficult to imagine that a normal radioactive constant can control the resultant effects. What will happen must resemble no mere death-rate based on statistics, but rather the mortality brought about by earthquake or flood. A large number of the specific atoms would be affected and a very great local rise in temperature would follow. There is, now, the further probability that this sudden rise will involve yet other elements in the catastrophe.

If this inference is justified, explosive phenomena in suns and nebulæ so far from being unaccountable must be regarded as inevitable, as being associated with gravitative attraction and the internal properties of the atom.

It is to be expected that such explosive phenomena would diminish in frequency and intensity as time advanced and elements of higher atomic weight became degraded. Thus, in primeval times, our sun may have been many times rent by such explosions. There appears to be evidence that central explosions of great violence occasionally occur even to-day.

How would the principle of the conservation of moment of momentum fare under conditions involving the translation of internal atomic energy into molar forms? J. JOLY.

Trinity College, Dublin, July 9.

Gas Pressures and the Second Law of Thermodynamics.

IN the June *Philosophical Magazine* Mr. Fairbourne endeavours to prove that in certain easily attainable cases the second law of thermodynamics might be circumvented. He attempts to show that if an enclosure be divided by a partition, the chance that a molecule of a rarefied gas will pass the partition, from the space I to the space II, may be modified, by a funnel, without affecting the chance of passing from II to I, so that a pressure difference will arise. He considers the simple case, shown in Fig. 1, of a right-angled "funnel" in two dimensions only, truncated so that the diameter at the end BC is twice that at AD. Taking a point O on BC he shows that, of the molecules passing through O, on the whole more than half will be reflected by AB or CD and less than half will pass through AD, since they can approach from an angle π while the angle between the limiting paths by which they can get through is in general less than $\pi/2$. He deduces that of 2N molecules striking BC in a given time less than N will pass through AD, while all of the N molecules reaching AD from the other side in the same time will cross it, so that on the whole more will come from II to I than *vice versa*.

The error in this argument lies in the fact that it is impossible to construct a line BC out of a number of points O; it is necessary to define the tolerance before one can say whether molecules have passed through O or not. As soon as this is done (by taking an element of length dl at O, and defining passage through O as passage through this length), it is clear that the chance of "passing through O" is not independent of the angle of incidence θ, but is proportional to $\cos\theta$, since dl is foreshortened for obliquely moving molecules. In any given case it will now be found that the total number of paths leading through AD is the same on both sides of the partition ZZ′. However, the following general proof of this equality should save the trouble of integrating particular cases. It applies to three dimensions and any shape of funnel.

It is clear that before the funnel (AB,DC) was added to the partition the chances of passing from

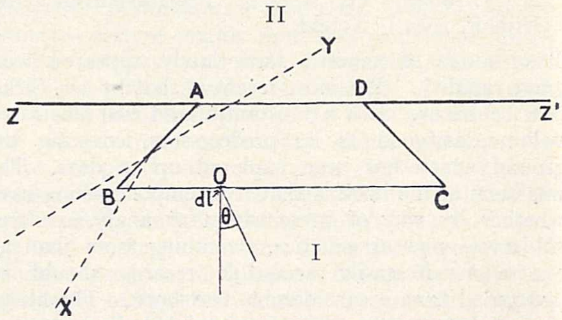


FIG. 1.

II to I and from I to II were equal, and that adding the funnel does not alter the chance of passing from II to I. If it is to have an effect then it must decrease the number of paths from I to II. But for every such path XY which it blocks it introduces a new path X′Y, and this is true of every point in any funnel. This result is of course well known in geometrical optics; if it were incorrect any temperature and energy density of radiation would be obtainable without work.

It may also be remarked that there is not only molecular roughness in even a polished wall, but thermal agitation of all the molecules of the wall; the argument that if the wall reflects light it should "reflect" a molecule is vitiated by the fact that the wave-length of visible light is about a thousand molecular diameters; and the argument that even if the direction of rebound is fortuitous the funnel should have an effect defies elementary hydrostatic theory.

Lastly, the mean free path of the molecules is irrelevant. Mr. Fairbourne assumes that his theory would not apply if there were a large proportion of encounters between gaseous molecules; but it is clear that if the effect of the funnel is to give on the whole a bias away from II to the average molecule striking it, it cannot matter whether that molecule retains the bias or hands it on to another in an encounter.

The effect, if there were one, should be proportional to the number of molecules striking the funnel per second, *i.e.* to the total pressure.

R. D'E. ATKINSON.

Clarendon Laboratory, Oxford, June 1.

IN reply to Mr. R. d'E. Atkinson's letter, I should like to point out that, while his conclusion is undoubtedly true with regard to light, it is by no means clear that analogy justifies his extension of this conclusion to the molecular problem under consideration in my paper. The fundamental conception of unchanging uniform concentration would appear incorrect when applied to particles proceeding between collision centres and entering a minute vessel, the diameter of which is considerably less than the mean free path of the gas concerned. This confusion of issue, introduced by regarding the problem of light as identical with that I was considering, may perhaps be brought out most clearly by the following calculation, which is almost identical with the one Mr. Atkinson suggests would be possible.

If ABCD (Fig. 1) is the figure dealt with in the paper, and DH, AF, PE all be inclined at angle α to BC, while DI is perpendicular to BC, and D′ is the

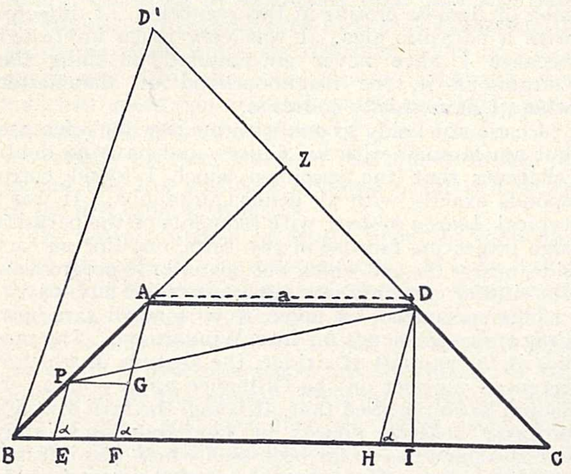


FIG. 1.

mirrored image of D with respect to BZ, P being the point on BZ such that angle EPB is equal to angle DPA, then the following relationships may be calculated.

Case 1, where α is not less than angle D′BC. By the usual laws of reflection, light approaching BC from below, approximately at angle α, must pass out at AD if it enters between E and H, but will be returned through BC if it enters either between B and E or between H and C.

$$\mathrm{EH}=\mathrm{EF}+\mathrm{FH}=\mathrm{PG}+a=a\cot\alpha+a.$$

Case 2, where α is not less than angle DBC, and is not more than angle D′BC. In this case only light entering between B and H will escape through AD.

$$\mathrm{BH}=\mathrm{BI}-\mathrm{HI}=\frac{3}{2}a-\frac{a/2}{\tan\alpha}=a(1\tfrac{1}{2}-\tfrac{1}{2}\cot\alpha).$$

Case 3, where α is less than angle DBC. In this case all the light will necessarily be returned through BC. Where α is greater than a right angle these three cases are merely duplicated.

Hence, if equal light intensity in all directions be assumed, and if A be taken as a constant representing its uniform concentration, then the ratio of the amount of light which passes from AD to BC to that which passes from BC to AD in unit time must be

$$\mathrm{A}\int_{\alpha=0^\circ}^{\alpha=90^\circ} a\sin\alpha\,.\,d\alpha$$

$$:\left\{\mathrm{A}\int_{\alpha=\angle \mathrm{D'BC}}^{\alpha=90^\circ}(a+a\cot\alpha)\sin\alpha\,.\,d\alpha+\mathrm{A}\int_{\alpha=\angle \mathrm{DBC}}^{\alpha=\angle \mathrm{D'BC}} a(1\tfrac{1}{2}-\tfrac{1}{2}\cot\alpha)\sin\alpha\,.\,d\alpha\right\}$$

$$=\mathrm{A}a:\left\{\mathrm{A}a\int_{\alpha=\angle \mathrm{D'BC}}^{\alpha=90^\circ}(\sin\alpha+\cos\alpha)d\alpha+\mathrm{A}a\int_{\alpha=\angle \mathrm{DBC}}^{\alpha=\angle \mathrm{D'BC}}(1\tfrac{1}{2}\sin\alpha-\tfrac{1}{2}\cos\alpha)d\alpha\right\}$$

$$=\mathrm{A}a:\mathrm{A}a\,(0{\cdot}643+0{\cdot}357),\ \text{approximately},$$

$$=\mathrm{A}a:\mathrm{A}a.$$

The above integration to equality is essentially dependent upon the axiomatic acceptance of the unchanging existence of equal concentrations or

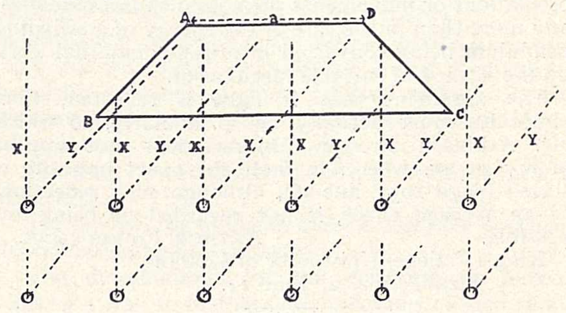


FIG. 2.

intensities in all directions, uniformly throughout the medium in which the cone is placed. Such unchanging uniformity of concentration might be presumed to exist in perfectly diffused light, but it cannot exist in gases, since changes of concentration occur as intermolecular collisions, and must be important in relation to the entering of vessels considerably smaller than the mean free path of the gas. The light problem is one of flow; the molecular problem may be regarded as one of (interrupted) oscillation, at least to a large extent.

If each of the little circles in Fig. 2 be taken to represent equal areas (or spheres if three dimensions are being considered), the probability of molecules proceeding outwards, from collision in one of these circles, along a path X, is equal to that of their proceeding from collision, in that same or any other equal circle, along a path Y, this being true however many circles are under consideration, even in the limit of their occupying the whole space within free path distances from the cone. If two directions, X and Y, are considered for a large number of such circles, regularly placed so as to be representative of the equal probability of collision in all parts, it is obvious that molecules approaching BC along directions X

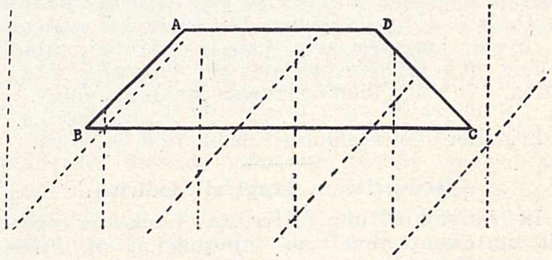


FIG. 3.

and Y, and starting from collision sources, do not cross BC in numbers proportional to the sines of the angles of these paths with BC, as has to be assumed in light calculations such as the one above, which may be illustrated by Fig. 3 where no collisions occur, and where the light approaches in two regular streams of equal concentration. The difference is due to the position of the opening BC relative to collision centres below it within less than free path distances, from which the approaching molecules will start, with equal probability of movement in all directions. The molecular problem would thus appear to approximate to the simple statement in my paper, in which the "points O" may consequently be regarded as little elements of area, and to be quite different from light calculations such as the one worked out above.

In connexion with Mr. Atkinson's claim that elementary principles would be defied if an effect were to occur, it is not obvious why this should be so (provided, as has always been emphasised, that the apparatus shall be sufficiently small to deal with the oscillations or movements of molecules individually), any more than in the case of the energy of a swinging pendulum being converted into useful external work by the agency of suitable mechanism.

The argument that if light is reflected, then molecules must actually be so similarly, to which Mr. Atkinson strongly objects, does not appear in my paper, where, in fact, the exact opposite is stated (page 1053, line 26), although such reflection, as an average effect, is not regarded as being impossible. ARTHUR FAIRBOURNE.

King's College, University of London,
Strand, W.C.2, June 22.

Polarisation of Diffused Light under the Sea.

I TOOK advantage of a recent opportunity to make some observations on polarisation of the diffused light in sea-water, using a detector consisting of four quartz prisms made up on the De Senarmont principle, combined with a Nicol. The depth was 30 feet, the sea-water very clear, and the day cloudy, with no trace of sky polarisation. The diffused light at the bottom was quite strongly polarised, the water behaving like a turbid medium observed at right angles to the incident beam, the plane of polarisation being perpendicular to the surface.

The greatest intensity was in the horizontal direction, diminishing rapidly as the angle of elevation increased, and disappearing completely long before the direction became nearly vertical. Repeated observations created a strong impression that the direction of maximum polarisation was not exactly horizontal, but very slightly inclined downwards. However, the difference, if any, was so small that it must be regarded as doubtful.

I should have liked to repeat observations on a day of blue sky, but the opportunity did not arise. The light from the sandy bottom and from a white plate did not show any trace of polarisation.

Apart from polarisation, it was interesting to observe the surface. It is not easy to look vertically upwards in a diver's helmet, but there was evidently a circular luminous area directly overhead, rapidly falling off in intensity without any sharpness of transition. It was a kind of inverse penumbra effect.

E. E. BROOKS.

Leicester City Technical School, June 30, 1922.

Discoveries in Tropical Medicine.

IN NATURE of June 24 Sir Ray Lankester repeats his statement that the transmission of *Filaria bancrofti* from infected to healthy men through the intermediation of the mosquito is not a sufficiently established fact. I trust you will permit me to state, for the benefit of those of your readers who may be puzzled by an assertion so discordant with current teaching, that at this school we shall always be happy to demonstrate sections of mosquitoes and of *human* lymphatic gland that show the facts of that transmission.

With regard to Sir Ray Lankester's other emphasised statement that "Manson did *not* discover the part played by the mosquito" in this transmission, we shall be happy to show Manson's original charts and drawings made in Amoy, and other necessary evidence that Manson did follow out the development of the embryonic and larval *Filaria bancrofti* in the stomach and body-cavity of the mosquito. This evidence, quite apart from any additions to it or corrected inferences from it, establishes the essential fact that the insect is the vital agent of transmission, since it releases the imprisoned embryo from the blood-vessels of its host, nourishes it until certain necessary organs are developed, and thus enables it to make a start in life. A. ALCOCK.

London School of Tropical Medicine,
Endsleigh Gardens, Euston Road, N.W.1,
July 5.

Ouramœba.

WITH regard to the notes by Messrs. Rowley and Kirkpatrick in NATURE of July 8, on the occurrence of Leidy's genus Ouramœba in England, it may be of interest to record that I have recently (a few days before their letters were published) found one specimen of *Amœba proteus* in this condition, *i.e.* infected with a parasitic alga. I was very much interested, because I have never encountered anything like Ouramœba in the neighbourhood of Manchester, where I have chiefly collected.

I have not Leidy's book with me now for reference, but am familiar with his figures, and have no doubt whatever that the specimen which I found corresponds exactly with his genus Ouramœba. It was a typical *Amœba proteus*, with filaments of the parasitic alga projecting fanwise in two tufts, one tuft on each side, nearer the end which was posterior in progression. Its vitality certainly was not impaired in any way.

This specimen was taken from a small tarn near Crag House farm, not far from Windermere. The tarn lies at the summit of a ridge, the altitude of which is given as 700 feet on the Ordnance Survey map. It should be emphasised that, although the tarn contains ordinary *Amœba proteus* in fair abundance, only one specimen has so far been seen which was infected with the alga. The other fauna of the tarn include very numerous Thecamœbida, some Flagellata, Ciliata, desmids, diatoms, etc., a fauna which corresponds fairly closely with that dealt with by Leidy in his book, and which is probably typical of open moorland country at high altitudes.

Amœba proteus is found in other tarns in this neighbourhood; but I have never seen any other specimen infected with the alga from these other localities, although, since reading Mr. Rowley's letter, I have again searched fresh material.

G. LAPAGE.

Bowness-on-Windermere, July 10.

Histological Stains.

WITH reference to Dr. Nierenstein's remark (July 8, p. 33) that the British dye industry would do well to pay attention to the supply of dyes suitable for histological work, it should be recorded that in 1919, when pathologists here had a difficulty in getting satisfactory stains, the Pathological Society of Great Britain and Ireland approached Dr. Levinstein in the matter and received from his organisation ample and most useful help which carried us on until reasonably good stains became available again through the ordinary trade channels. A. E. BOYCOTT.

July 8.

The Structure of Organic Crystals.[1]

By SIR WILLIAM BRAGG, K.B.E., F.R.S.

IT may be said with truth that modern advances in physical science are due in the main to the acquisition of the power to handle the individual atom. Until the present time we have always attacked the problems of matter by examining the behaviour of atoms or molecules in groups. The new powers arise in two ways :—

In the first the individual atom is endowed with excessive speed and energy, and is able to make its individuality felt on this account. The α-particle of the radioactive radiations is a helium atom moving with a speed of the order of one-tenth of that of light. While in possession of the relatively tremendous energy which the speed implies it can, unaided, make a visible impression on a fluorescent screen. It can pass through thousands of other atoms without sensible deviation and, if occasionally it suffers violent deflection, it has penetrated to the very core of the atom which has deflected it. Rutherford has shown us what important deductions can be drawn as to the construction of the atom by examining these rare and sharp deviations, and is going even further in examining the shattering effect which the deflecting atom may itself experience. So also, the electron endowed with sufficient speed can traverse matter and bring about its ionisation and other effects of great interest, but if its velocity becomes less than one million metres per second this free existence disappears. It is attached to the first atom it meets.

The second method of attack upon the individual atom proceeds on very different lines. It is by way of the mutual action of X-rays and crystals. When we are examining things by eyesight we follow the influence of the objects that we look at upon the waves of light. If we wish to penetrate deeper into the minute, we take advantage of the optical effects of lenses and build microscopes : but, even then we cannot attack individual objects containing less than many thousands of individual atoms. A limit is set by the difficulty that light cannot show us the form of things which are much smaller than the wave length of the light itself. With the aid of the very short waves known as X-rays we can make our way down to objects ten thousand times smaller, but by itself this extension of our powers would be inefficient, because the effect due to one atom or one unit of pattern would be inappreciable. Here lies the value of the crystal, which, being an aggregate of some small atomic pattern repeated again and again through space, shows up on a measurable scale the properties of the atoms in the single unit. By the combination of X-ray and crystal we can examine the very foundations of material construction. It is difficult to set a limit to what may be the consequences of the exercise of these powers since we can now examine all physical effects, so to speak, at their source, and must in the end be able to refer all the physical and chemical properties of materials to the properties of the individual atoms and their mutual forces. So far the new methods have scarcely begun to show their full strength. A few inorganic crystals have been examined with a view of discovering their structure, but the new field of research is barely entered. Inviting roads lie before us pointing in numerous directions.

Very little has yet been done in the way of applying the new methods to the structure of organic crystals, although no study could be more tempting. Their vast variety of form, the perfection of their structure, their importance, all urge us forward, and especially the fact that the whole progress of organic chemistry shows that the science depends upon laws of position with which the X-rays are especially qualified to deal. The difficulty at the outset lies in the complexity. In the naphthalene molecule there are 18 atoms : in what way can we expect by means of X-rays to solve the intricate problem of their relative positions ? Our first attempts to solve inorganic crystals depended for their success upon two facts :—

The first, the simplicity of the structures which were attacked.

The second, the guidance derived from the principles of crystallographic symmetry.

The determination of the structure of rocksalt opened a way to further determinations of such simple crystals as the diamond, zinc blende, fluorspar, and others. In all these the principles of symmetry supplemented the knowledge derived from the examination of the intensities of X-ray reflection by the various crystal planes. As the work has proceeded in the hands of observers in many countries, other principles have emerged or are emerging which render further and very valuable aid so that problems appear to be coming within our grasp that not long ago seemed most difficult of solution.

Of these principles, one began to appear in consequence of the very earliest results. It was a very striking fact that in crystals of polar substances the molecule seemed to disappear ; it was in fact dissociated, and the structure of the crystal depended upon the grouping of the positive ions round the negative and of the negative ions round the positive. In rocksalt each metal atom is surrounded by six atoms of chlorine and *vice versa*. If we accept this as an indication of the general character of such structures, adding to it the condition that every atom is to be like every other atom of its own kind in respect to relative distances and orientations of all its neighbours, it becomes possible to foretell the probable form of structure, using the X-ray methods for subsequent verification. This method of proceeding may be very much easier than if it were taken in the reverse way. We might for example have gone far to foretell the structure of fluorspar. It is an ionic compound in which the calcium atoms are doubly charged and fluorines are singly charged. Each positive is to be surrounded, therefore, by twice as many neighbours as each negative by positive. The fluorspar structure in which the metal atoms are arranged at the corners and the face centres of the cube, while the fluorines lie at the centres of the eight small cubes into which the larger ones can be divided is one of the very few regular ways in which this numerical relation of 2 to 1 can be carried out. So also in ice, the 2 to 1 arrangement is

[1] Discourse delivered at the Royal Institution on Friday, May 19.

carried out in a second of these ways, the relative numbers of neighbours being four to two. It is the lightest and most open of the 2 to 1 structures, and is consistent with the low specific gravity of ice and with the possibility of compressing the substance into denser forms: at the same time it shows the six-pointed arrangement and the featheriness of the snow crystal.[2]

The earlier results at the same time showed that in the diamond we had a construction of very different properties and nature. Here the atoms are electrically neutral and are bound to one another, not by electrical attraction from centre to centre, but by a more intimate process which probably consists in some way of a sharing of structural electrons. The diamond is on this account the hardest of known substances.

These considerations amount to a recognition that the bonds between the atoms may be of very different characters though it may be difficult to draw hard and fast lines between them. We can say that there is a very strong electron sharing bond of which the diamond is typical, and that there are ionic bonds in polar compounds which in general are of a weaker character, as, for example, in rocksalt, though on the other hand they may be strong when, as in the ruby, the ionic charges are large.

Lastly, there is a third type, which is found in the organic crystal, where it would appear that the separate molecule can be distinguished. The atoms in each molecule are strongly tied together, but the forces that bind molecule to molecule may be described as residual. They would appear to be weak fields concentrated at definite points on the molecule, the positive and negative charges to which they are due lying within it.

The second principle which emerged fairly early in the experiments was described by my son in an address which he gave in this Institution some time ago.[3] We may call it the principle of radii of combination. The distance between the centre of one atom and the centre of a neighbour can in many cases be measured with great accuracy: we can compare these distances when substitutions are made in isomorphous compounds. The replacement of fluorine by chlorine, chlorine by bromine, bromine by iodine in a series of salts produces changes in the distances which imply that the radius of any one of the atoms mentioned may be treated as a constant within the range of the substitution considered. The accuracy is amply sufficient to give useful assistance in crystal analysis. It would not be true, however, to say that each atom has an invariable radius, and indeed the original statement of the principle purposely refrained from going so far. It is not right to speak of *the radius* of an atom; it is better to speak of *a radius of combination*. We may take an illustration from the behaviour of arsenic, antimony, and bismuth. The crystals of these substances are trigonal in form,[4] plainly showing that the properties of each atom are not the same in all directions within the crystal: in fact, analysis shows that each atom is fastened to three on one side of it by much closer bonds than to three atoms on the other side. One bonding resembles more closely that of the diamond, the other that of a metal where free electrons keep the atoms together by electrostatic attraction. It may be said that the atom behaves as a metal on one side and a non-metal on the other. At any rate, there are two radii of combination varying with the nature of the bond. The metallic bond is the weak one and the cleavage plane cuts only through such bonds. It seems very likely that in this way we can understand the formation of crystals of different type when these elements enter into their composition. For example, in the cubic form of senarmontite (Sb_2O_3) the atoms of antimony are completely separated; each touches six atoms of oxygen, while each oxygen touches four atoms of antimony. Antimony is here behaving as a metal only, so that we represent it in a model as a sphere, and the uniform spheres of antimony and of oxygen naturally build into a simple crystal. It is a cube in which the atoms of antimony occupy the corners and centres of the faces while the six oxygen atoms lie at the centres of six of the eight small cubes into which the large one can be divided.

There is, however, an alternative form of Sb_2O_3 known as valentinite, which is ortho-rhombic. Analysis, so far as it has gone, though it is not yet complete, points emphatically to the conclusion that here atoms of antimony are pairing, the bonds between the members of a pair being of the stronger variety already referred to. We now have an elementary body of a dumb-bell shape which, when forming part of the crystal structure, will naturally cause a deviation from a simple cube.

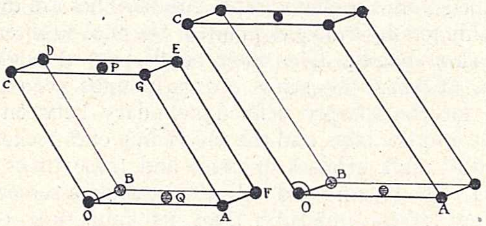
Yet again, there are principles which are barely established as yet, though it seems probable that they will be found of material assistance in analysis. The greater expansion of some crystals in certain directions than in others seems to depend upon the nature of the bonds. Bismuth expands more along the axis than across it, as we might expect from the fact that in the one expansion the weak bonds alone can be operative. In the same way diamond has an extremely small expansion co-efficient because all the bonds are of the strongest kind, but in graphite, on the other hand, the expansion along the axis may be described as enormous. Mr. Backhurst finds an increase in length of 3 per cent. for a rise of 900° C. At the same time, so far as can be inferred, the expansion across the axis is still quite small. In one case weak bonds only are concerned, in the other, strong bonds of the same kind as in the diamond.

It is when all these considerations are taken into account that it seems possible to make an attempt upon the structure of the organic crystals. They are, of course, very complex; naphthalene contains 10 atoms of carbon and 8 atoms of hydrogen, and our ability to interpret X-ray evidence, that is to say, the relative intensities of reflection by the different planes in different orders, is not sufficiently advanced to enable us to place so many atoms in their proper position in the cell from this evidence alone. We can readily find the size of the unit cell, show that there are two molecules in it, and that the points, each of which represents a whole molecule, are to be placed as is shown in Fig. 1, but without some further help we can frame no hypothesis on which to proceed.

Suppose now that we compare the structures of diamond and graphite. As my son showed long ago,

[2] Proc. Phys. Soc., London, vol. xxxiv. pt. 3, p. 98.
[3] See *Phil. Mag.*, Aug. 1920.
[4] James and Tunstall, *Phil. Mag.*, Aug. 1920 and July 1921; Ogg, *Phil. Mag.*, July 1921.

the structure of graphite must be derivable from that of the diamond by separating to nearly double their previous distance the sheets of atoms parallel to one of the cleavage planes of the latter crystal. The question has been very carefully considered more recently by Hull in America and by Debye and Scherrer on the Continent in the hope of finding more exactly the details of the movement: they do not quite agree.



Naphthalene. Anthracene.

FIG. 1.—Unit cells of naphthalene and anthracene drawn to the same scale.

	OA = a.	OB = b.	OC = c.
Naphthalene	8·34	6·05	8·69
Anthracene	8·7	6·1	11·6

Naphthalene α = BOC = 90°, β = COA = 122° 49′, γ = AOB = 90°.
Anthracene α = BOC = 90°, β = COA = 124° 24′, γ = AOB = 90°.

Fig. 2 represents the change as described by Hull. The bonds between the atoms in each sheet are unaffected apparently, but those between sheet and sheet are replaced by something much weaker. The diamond is typical of hardness, the graphite is used as a lubricant. If the hexagonal rings of which the sheets are formed have survived this violent change, why not suppose that they may survive the further change when the sheets break up into ring structures? In other words, suppose that the benzene ring is really a fact, not merely a diagram; the distance between atom and atom in

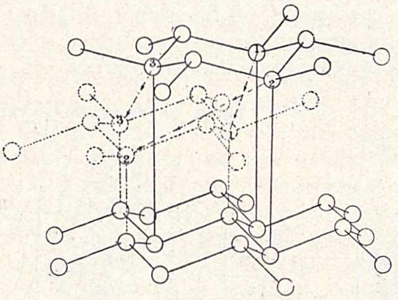


FIG. 2.—The fine lines of the diagram show the structure of graphite. By moving the top layer to the position shown by the broken lines the diamond structure is obtained.

the ring is 1·54 Å.U. as in the diamond, and perhaps we may add that the atoms are not all in one plane, but are arranged, as may be seen in Fig. 3. We then proceed to test this hypothesis by finding whether we can fit together molecules of the assumed size and shape into the cells which hold them. From X-ray studies we know the exact form and dimensions of the cells, and can learn also much concerning the relative distributions of the molecules within them. It appears at once that in the few simple cases which have been examined an excellent fit is possible and, more than that, we find encouraging signs that the structural idea has been chosen rightly. For instance, the comparison of the cells of naphthalene and anthracene, one a two-ring, the other a three-ring combination, shows that two of the axes of the cell remain constant, while the third has grown by an amount which is nearly the width of the benzene ring. From these and various other indications we build a structure such as is represented in Figs. 3 and 4. It would seem that the molecules are linked together side to side more strongly than from end to end, and that is why these and similar crystals cleave across the end or β position.

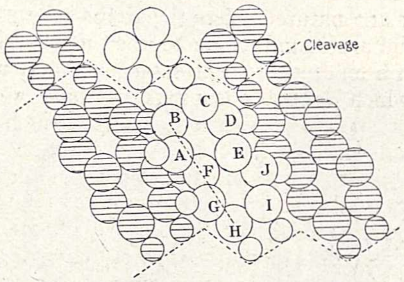


FIG. 3.—Showing mutual relations of three naphthalene molecules and parts of others.

The unshaded circles between the two cleavage planes represent a molecule as at Q (Fig. 1). The shaded represent molecules B and F in the same figure. The small circles represent hydrogen atoms, but their size is uncertain.

Diameter of carbon atom = 1·50. BH = 4·92. Projection of AD on the plane of the diagram = 2·50. Benzene ring consists of atoms A ... F only.

If we examine α-naphthol in which hydrogen at the side of the naphthalene molecule has been replaced by an OH group, we find that the standard cell contains four molecules, which is what we should expect, for each of the four α positions must be represented. When the OH group is taken from the side and put at the end, we find that the cell has shrunk sideways and grown lengthways by the amount we should expect to result from the addition of an oxygen atom. When as in acenaphthene a complex group of atoms is attached to one side of the molecule and the crystal

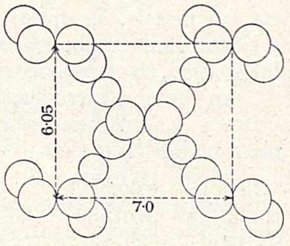


FIG. 4.—Section of naphthalene cell perpendicular to the axis of c, showing α-hydrogens connecting the molecules side to side.

to our surprise becomes more regular than before, right angled instead of oblique, we find an explanation in the fact that there are now four molecules within the cell instead of two, and that by sloping in pairs in opposite ways they increase the symmetry of the crystal.

These examples may serve to show how an attempt may be made to arrive at a knowledge of the structure of these organic compounds with, I think, some success. It seems justifiable to see in the rigid and queerly shaped molecule attaching itself at definite points, and with great precision of orientation to neighbouring molecules, a cause of the immense multiplicity and, at the same time, the accurate form of organic crystals, and indeed to find here the foundations of organic chemistry.

The Action of Cutting Tools.

By Prof. E. G. Coker, F.R.S.

ENGINEERING activity is so largely dependent on the action of cutting tools, that it is not surprising to find a very large amount of research work has been devoted to its study, and at the present time there are in England two committees actively pursuing researches in this field, in addition to private investigators. At the suggestion of the Cutting Tools Research Committee of the Institution of Mechanical Engineers, of which Sir John Dewrance is chairman, some experimental studies of a preliminary character have been made recently at University College, London, on transparent bodies subjected to the action of cutting tools, and the double refraction produced by stress has been used to measure the stress distribution in the cut material. Similar experiments have also been carried out on some glass-cutting tools used for turning and planing operations.

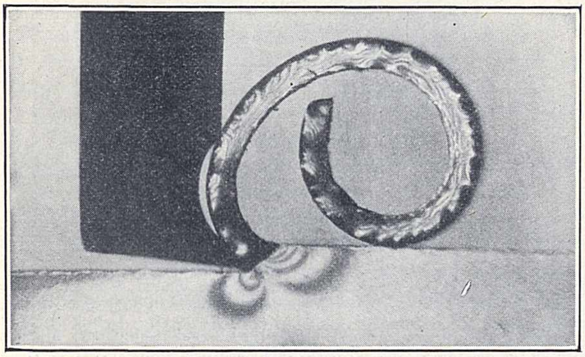


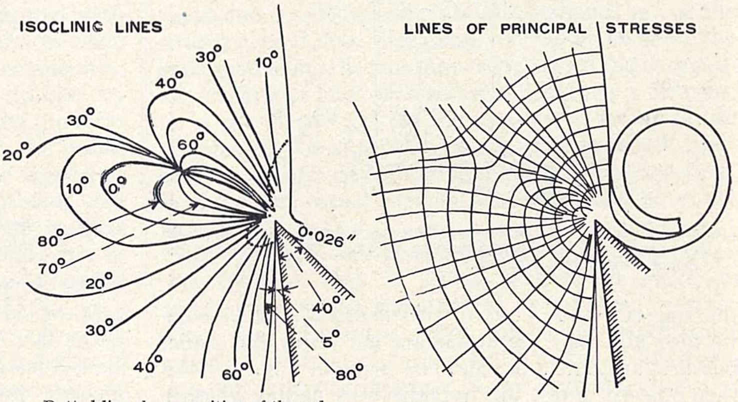
Fig. 1.—Steel tool planing a strip of nitro-cellulose.

The photo-elastic method has many advantages over direct experiment on metals, as up to and, in fact, well beyond the elastic limit of the transparent nitro-cellulose used, the stress distribution produced can be measured with considerable accuracy at all points in a disk or flat plate under the action of a tool. The optical effects give, at once, a measure of the difference of the principal stresses at a point, the lateral contractions afford a measure of their sum, and the isoclinic lines map out the directions of the stresses. Existing literature shows how very difficult it is to obtain similar information from the metal itself when under the action of a tool. Since the distributions are similar up to the elastic limit of each material, owing to the absence of elastic constants in the fundamental equation $\nabla^4.\chi=0$, there are obvious advantages in a study of the characteristics of cutting tools by these means. The general phenomena observed when a tool is cutting are shown in Fig. 1, where a steel tool is planing a plate of nitro-cellulose in a circularly polarised field of light. It will be observed that colour bands spring from the cutting edge of the tool and curve round in approximately circular arcs to meet the boundary, indicating the existence of variable radial compression stress in the area in front of the tool, and a similar state of tensional stress behind it.[1] Measurements of the principal stresses and their inclinations show that this is approximately what obtains, and a very fair idea of the stress conditions in the material can be obtained from the photograph if radial lines are drawn in all directions from the point of the tool to intersect the colour bands. The outer bands pass through all points at which the stress is 1150 pounds per square inch, for the sharply defined boundary between the purple and the blue, and the succeeding ones reckoning inwardly mark stresses of twice and three times this value. The fourth band indicates possibly a somewhat different stress intensity than its numerical order warrants, owing to its close proximity to the black area in which intense plastic stress is developed at and near the cutting edge of the tool. An interesting feature is the partial recovery of the material, for the black area is met with only at this place. The shaving again shows brilliant colour effects after it has finally left the tool, but later becomes obscured, again owing to the further curl developed due to contact with the parent material.

Careful measurements show, however, that the actual state of stress, excluding the plastic field, is somewhat more complicated. The stress is never quite radial, and the isoclinics are therefore not straight lines, but are always curved somewhat, as indicated in Fig. 2, which shows a set of isoclinics obtained from a disk of about six inches in diameter when subjected to the action of a turning tool with a somewhat acute cutting angle. The lines of principal stress confirm this, and the valves of the minor principal stresses appear to be small in the cases examined so far, and to a first approximation the distribution of principal stresses $\widehat{RR}$ and $\widehat{\theta\theta}$ may be taken to be of the type

$$\widehat{RR}=(-2P/\pi)\,.\cos\theta/r$$

where $\widehat{\theta\theta}$ is small, and the angles are measured from the radial black brush dividing the tension from the compression area. The position of this latter brush



Dotted line shows position of the red band of 1st order.

Fig. 2.—Isoclinics and lines of principal stress in a disk under the action of an edge-turning tool. From the Proceedings of the Institution of Mechanical Engineers, by permission of the Council.

[1] "An Account of some Experiments on the Action of Cutting Tools," by Prof. E. G. Coker and Dr. K. C. Chakko, Proceedings of the Institution of Mechanical Engineers, 1922.

depends on the cutting angle of the tool, and also upon its rake and clearance, but investigation has not proceeded far enough as yet to define accurately the influence which each element has upon its position.

A somewhat remarkable change from these conditions is produced when the cutting edge is not so perfectly sharp as it is possible to make it. It then becomes apparent that the shaving is no longer cut from the main body, but is broken or torn away by the continual forcing of a wedge between the shaving and the main body of the material, after the latter has once been penetrated. The shaving breaks away at a point A above the cutting edge (Fig. 3), mainly owing to the

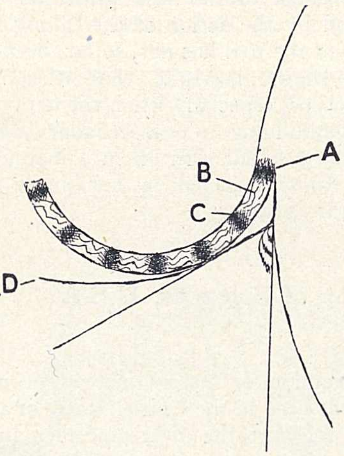


FIG. 3.

bending action exerted by the raking face of the tool, and is so much overstressed at this place that all colour effects are obliterated. An intense and permanent black patch is therefore produced separated by a less stressed part B, in which plastic stress colour effects are observable from a similarly much more overstressed part C immediately preceding. These effects are repeated at regular intervals as is indicated in Fig. 3 in a somewhat diagrammatic form, and are accompanied by a rhythmic pulsation of the colour bands in phase with this phenomenon. The tearing away of the shaving in this manner produces a rough uneven surface on the material, which in planed work is therefore not truly flat, and in turned work is not perfectly cylindrical. It is probable that this influences the character and kind of chip produced in brittle materials, as it undoubtedly influences the shaving from an elastic material which is capable of assuming a plastic condition. Moreover, it is sometimes found that when this latter condition occurs the tool is acting in a two-fold capacity, for not only does it break off a shaving, but it may also pare off the irregularities as the point of the tool comes in contact with them, so that occasionally a second and much thinner shaving, D, is produced, and peeled off as indicated in Fig. 3, by a true secondary cutting action. Double shavings are sometimes produced in this manner when steel is turned in a lathe, and it is probable that the fine powder, which can often be observed falling away from a tool working on cast iron, is due to this secondary cutting action.

In tools with multiple cutting edges the same general features of stress distribution are observed in the material. They are sometimes accompanied by additional phenomena, as, for example, with the milling

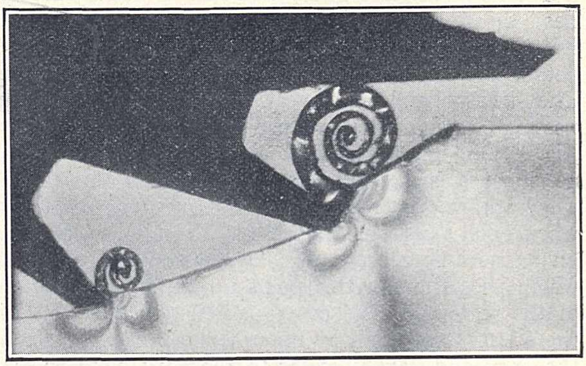


FIG. 4.—Steel milling cutter operating on a pl ate of nitro-cellulose.

cutter, shown in Fig. 4, where the depth of cut is variable owing to the uniform movement of the material up to the cutting edges, which are also turning at a definite and uniform rate. The shaving cut from the trochoidal contour is continuously increasing in thickness therefore, as the cut advances, and in the

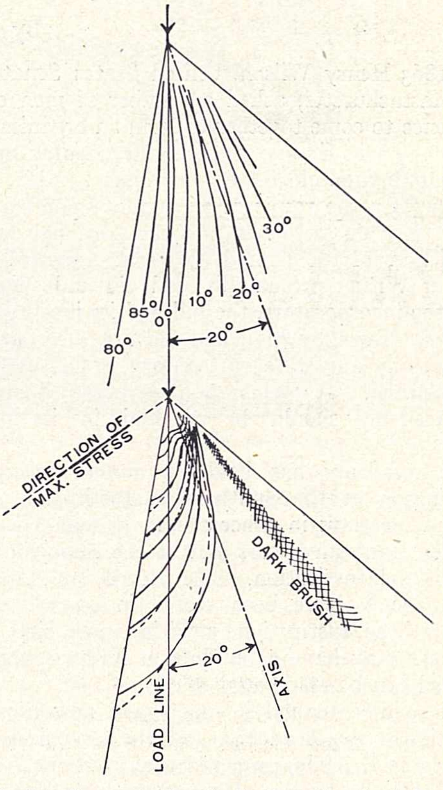


FIG. 5.—Isoclinic lines and colour bands observed and calculated for a wedge of angle 60° when a load of 50 pounds is applied at an angle of 20° with the axis. Colour bands observed are shown in full lines; equivalent stress lines given by theory are shown dotted. From the Proceedings of the Institution of Mechanical Engineers, by permission of the Council.

present instance is being torn off rather than cut, as the characteristic markings for this kind of action occur in a very pronounced manner. If sufficient travel is given to the work, the separate lobed colour bands springing from each cutting edge, and denoting approximate radial stress, ultimately coalesce before the end of the cut, and the stress distribution becomes much more complicated.

The stress in glass tools when cutting nitro-cellulose has been studied, and it is found that when the material is being removed in a thin shaving by a true cutting action the stress system is of a simple radial type. The colour bands are very nearly arcs of circles passing through the cutting edge as indicated in Fig. 3, and are such as would be produced by the action of a concentrated force applied at this place. They are, in fact, of the same type as those obtained when a non-axial force is applied at the apex of a wedge, giving isoclinic curves and colour bands (Fig. 5), all of which pass through this point up to the yield point of the material. The centres of the circular arcs of these latter bands all lie upon a line passing through the apex and perpendicular to the dark band shown in Fig. 5, which marks the region of no stress. They are, therefore, approximately consistent with Michell's theory of stress in a wedge,[1] and have been shown experimentally, in the paper referred to above, to be in good agreement therewith along the line of action of the applied force. The stress system is found to be almost entirely radial and expressed by

$$\widehat{rr} = -c \cdot \frac{\cos(\alpha - \phi)}{r},$$

along this line—where α is the inclination of the outer face to the line of centres of the colour bands, and ϕ is the inclination of the applied force to the same face. Along each colour band $\widehat{rr}$ is practically constant. The value of the constant c is also expressible in terms of the force P, the angle α and the angle γ of the wedge. The stress system in the case when the material is being torn off by the action of the raking face of the wedge angle of the tool has not, so far, been made out. Experiment shows, however, that it is of a more complicated type, especially when the action is accompanied by the building up of a secondary wedge on the tool from the material torn off in a manner which is familiar to those engaged in machinery operations involving heavy cuts.

[1] Proceedings of the London Mathematical Society, vol. xxxiv., 1902, and Love's "Theory of Elasticity," 2nd edition, pp. 208-209.

The New Building of the National Academy of Sciences, U.S.A.

By Dr. C. D. WALCOTT.[1]

IN 1863 Henry Wilson, United States Senator from Massachusetts, asked a number of men eminent in science to come together to form an organisation by which the scientific strength of the country might be brought to the aid of the government. This meeting was directly the result of an Act of Congress passed March 3, 1863, incorporating the National Academy of Sciences of the United States of America. While Senator Wilson presumably had aid and suggestions from the incorporators, the bill had its inception with, and was drawn by him, and did not incorporate the Academy in any state or territory, or in the District of Columbia. It seems to have been his idea that the Academy should be national in its broadest sense.

The Academy has held its annual meetings in Washington at the Smithsonian Institution and its autumn meetings in other cities. Joseph Henry was president for many years and at the same time secretary of the Institution. The records and library of the Academy have been stored in several hundred boxes at the Institution, awaiting such time as the Academy may have a building of its own where this material can be made available.

The semi-centennial in 1913 gave new life to the activities of the Academy, and the foreign secretary, Dr. George E. Hale, proposed then that the Academy should have a home. He prepared tentative plans and had them put in shape by an architect. These plans provided laboratories and a library for the use of the Academy and resident men of science for research work.

The project was not to be long delayed, for the world war coming in 1914 changed and broadened the thought of the world. What started to be a battle of armed forces turned to competition between the countries at war in creative scientific research, looking to the destruction of masses instead of individuals. This led to the need in the United States of a body that could bring together the most able men in the fields of science for the solution of war problems. Dr. Hale, conceiving the need for such a service long before it was an actual necessity, proposed that the Academy take preliminary steps in the organisation of the scientific resources of the United States, and this was the beginning of the National Research Council which rendered such effective service at the request of the President of the United States during the war.

Appreciation of this service from the Academy was shown in an executive order issued by President Wilson, directing the National Academy of Sciences to continue the Council. Under this order the Research Council was reorganised on a permanent peace basis as an agent of the Academy, and the need of the Academy for a home was accentuated. Dr. Hale's precious plans were discussed at length, but the question of available funds continued. The quarters in the Smithsonian Institution, already too crowded, could not afford room for this new body, and temporary space elsewhere was found in the Munsey Building; then a residence at 16th and L Streets, having twenty-one rooms, was secured. A little later a larger building at 16th and M Streets was occupied, until the present location at 17th and Massachusetts Avenue was leased.

Early in these renewed activities strenuous efforts were made to secure a permanent endowment and money for a building for the Academy, and a suggestion was made to the Carnegie Corporation of an endowment and building for the Academy and Research Council, resulting in an offer of 5,000,000 dollars, provided the Academy would secure a site and present satisfactory plans. The amount needed for the purchase of this site was apportioned, so that the entire country might have a part in the great enterprise. The raising of funds for the purchase of the

[1] Paper read before the National Academy of Sciences on April 24.

ground was accomplished through the efforts of Dr. Hale, Dr. Millikan, and others.

The lot purchased by the Academy is known as Square 88. It contains 189,755 square feet. Originally its highest point was in north-west corner and its lowest point was under water in the river at the south-east. To-day its lowest point is about 24 feet above high water and its highest 41 feet. The borings show that there is a fill of from 5 to 10 feet where the building will stand, from 6 to 28 feet of clay and sand, and from 7 inches to 3 feet of decomposed rock.

The building planned has a frontage of 260 feet and is 140 feet deep. The height above the first floor is 60 feet. The vestibule is 11 by 20 feet; the entrance hall, 36 by 21 feet; the central hall, 64 by 24 feet; the library, 36 by 64 feet; the lecture-room, 34 by 50 feet. The five exhibition halls range in size from 26 by 14 to 34 by 21 feet.

The total number of square feet of floor space, exclusive of elevators, doorways, and hallways, is 39,874. This includes exhibition space amounting to 14,571 square feet, lecture and entertainment space of 7982, and 14,786 square feet for administrative purposes. Every modern convenience and facility will be provided.

Having brought you thus far, let us assume that we are on our way to the annual meeting in 1924. Walking west along B Street, half-way between 21st and 22nd Streets, we find a broad walk on our right, with reflecting pools in the centre leading through a formal effect of trees and shrubs to a building in the middle of the square surmounting a series of terraces. It is the home of the National Academy of Sciences and the National Research Council—a marble structure of fine proportions, standing out in bold relief against the blue sky in the morning sunlight (Fig. 1).

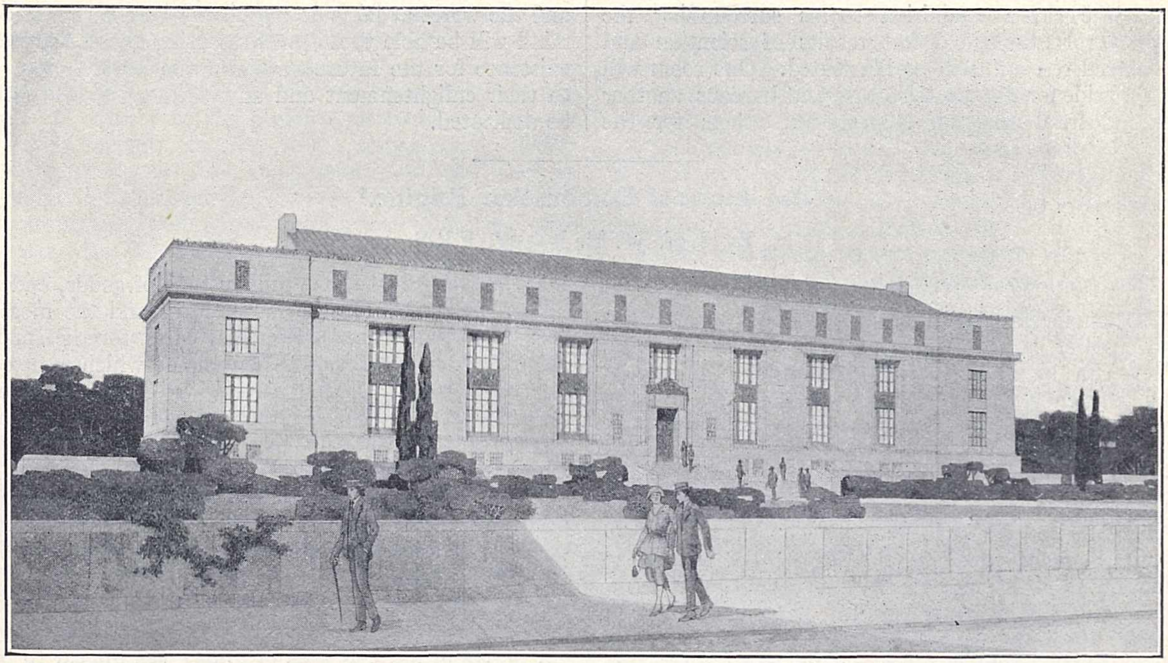


FIG. 1.—New building to be erected in Washington, D.C., for the National Academy of Sciences and the National Research Council.

Facing the Lincoln Memorial, the marble building in simple classical style will rise three stories from a broad terrace. On the first floor there will be an auditorium seating some 600 people, a lecture-hall holding 250, a reading-room, library, conference rooms, and exhibition halls. The basement will contain a cafeteria and kitchen. The two upper floors will be devoted to offices.

The building is the gift of the Carnegie Corporation of New York, while the ground was bought at a cost of nearly 200,000 dollars through the donations of about a score of benefactors. Bertram Grosvenor Goodhue of New York is the architect. He is one of the best-known architects in the country, and designed the St. Thomas Church, the West Point Building, the Nebraska State Capitol, and many other buildings. The contract for the construction of the building has been let to Charles T. Wills, Inc., of New York, and it is expected that the building will be ready for occupation in the autumn of 1923. Lee Laurie, the sculptor, has been selected to do the decorations, which will symbolise and depict the progress of science and its benefits to humanity. A series of bronze bas-reliefs will show a procession of the leaders of scientific thought from the earliest Greek philosophers to modern Americans.

On passing through the entrance hall the visitor will find himself in a lobby rotunda. Here he will see in actual operation apparatus demonstrating certain fundamental scientific facts that hitherto he has had to take on hearsay. A coelostat telescope, mounted on the dome of the central rotunda, will form a large image of the sun on the white surface of a circular table in the middle of the room. Here visitors will be able to see the sun-spots, changing in number and form from day to day, and moving across the disc as the sun turns on its axis. A 60-foot pendulum, suspended from the centre of the dome, will be set swinging through a long arc, repeating the celebrated experiment of Foucault. The swinging pendulum will mark an invariable direction in space, and as the earth of the building revolves beneath it, rotation will be plainly shown by the steady change in direction of the pendulum's swing over a divided arc.

Two great phenomena of Nature, the sun and the rotation of the earth, are thus to be exhibited. Other phenomena to be demonstrated in striking form in the central rotunda are magnetic storms, earthquakes, gravitational pull of small masses, the pressure of light, the visible growth of plants, swimming infusorians in a drop of ditch water, living bacteria, and other interesting phenomena.

In the seven exhibition rooms surrounding the central rotunda, the latest results of scientific and industrial research will be illustrated. One room will be set aside for the use of Government bureaus, another for industrial research laboratories, others for the laboratories, observatories, and research institutes of universities and other institutions. The newest discoveries and advances in the mathematical, physical, and biological sciences and their applications will be shown in this living museum, in which the exhibits will be constantly changing with the progress of science. One week there may be displayed the latest forms of radio-telephony; the next perhaps a set of psychological tests or a new find of fossils or a series of synthetic chemical compounds. Such a mutating museum will continue to attract and instruct large numbers of visitors and residents.

We call it the building for the National Academy of Sciences and the National Research Council, but in reality it should be the national home of science in America, and will be looked upon by our fellow-citizens and the world at large as the place where the creative mind will be able to do much to bring about a better existence for the future people of the world, for it is to their enlightenment and advancement that it will be dedicated.

The Internal Combustion Engine.[1]

By Prof. W. E. DALBY, F.R.S.

The Influence of the Internal Combustion Engine.

TO engineers the terms horse-power and horse-power hour have strictly technical meanings. They can be illustrated by comparing the weight and efficiency of an aircraft engine and a locomotive engine. An aircraft engine can be built with about 2½ lbs. of metal per horse-power as against approximately 250 lbs. of metal per horse-power in a locomotive engine. An aircraft engine requires about ¾ lb. of fuel oil per H.P. hour as against 3 lbs. of coal per H.P. hour used by the locomotive engine, in addition to which the locomotive engine must carry about 3 gallons of water per H.P. hour. All these, of course, are round figures. It is the extreme lightness of the petrol engine in relation to its power which has made it possible to develope aircraft.

An internal combustion engine of the Diesel type is built to use heavy oils, and has provided a prime mover by means of which the submarine was able to develop so considerably during the war. Thus the internal combustion engine helped to sink our food ships, but at the same time helped to save the situation by driving the agricultural tractor. Few, perhaps, realise fully how serious was our position in 1917. Horses were required for the Army and were being taken from the farms; but the agricultural tractor replaced them at the plough and thus made it possible to maintain the necessary food supplies.

Probably the greatest effect of the internal combustion engine on our national life is its influence on road transport. Standing at Hyde Park Corner twenty years ago a motor car would have excited notice; standing there to-day it is almost true to say that the horse-drawn vehicle has practically disappeared. The internal combustion engine is displacing the horse from the streets, and is even causing the railway companies grave concern. The chairman of one of them stated at the last half-yearly meeting that the companies had lost 9 million tons of goods, and 6 million passengers to the motor lorry and the motor car. This is a remarkable achievement for the small 16-20 H.P. internal combustion engine which is fitted in these vehicles. During 1921 about 800,000 licences were issued to vehicles propelled by internal combustion engines and the tax on them amounted to about ten million pounds.

These brief considerations indicate how profound has been and is the influence of the internal combustion engine in shaping our destinies. It has conquered the air, and has given us a prime mover useful in farming and in transport. It is influencing the policy of our railways, and will shortly so transform our outlook and our modes of life that men of to-day will appear to be separated from their boyhood not by a few decades but by a few centuries.

Some Problems of the Internal Combustion Engine.

Considering combustion from the point of view of the Kinetic Theory of gases, but without attempting to explain the nature of the differential attraction between molecules, most of the energy developed in the cylinder of an internal combustion engine arises from the fact that oxygen combines with carbon and hydrogen to develop large quantities of heat. The function of the engine is to convert as much as possible of this heat into mechanical work.

It can be deduced by the laws of gases that the molecules at 22° C. and atmospheric pressure require 729 times the volume they occupied as a liquid. This can be illustrated by "air patterns" representing the distribution of molecules in the air. Actually the molecules are flying about at a high velocity across the vessel the sides of which they are continually bombarding and therefore exerting pressure on them.

Calculation from the kinetic theory of gases shows that at 22° C. the oxygen molecules in the air are flying at a velocity of about 1600 ft. per second, the nitrogen

[1] From a Discourse delivered at the Royal Institution on Friday, May 26.

molecules at about 1700 ft. per second. This velocity is not the mean but the square root of the mean square of the actual velocities of the particles. The molecules collide and zig-zag about in the enclosing vessel so that it is only by imagination that we are able to conceive them as standing still and forming a pattern something like the pattern on a wall-paper.

When a spark is passed in a mixture of air and a hydrocarbon such as pentane a re-arrangement of the molecules takes place. The 5 atoms of carbon in the pentane molecule produce 5 molecules of carbon dioxide; 12 atoms of hydrogen produce 6 molecules of steam. Before ignition there are 41 molecules including 32 molecules of nitrogen. After the explosion there are 43 molecules, nitrogen taking no part in the change. Oxygen ceases to exist as a separate entity. The result is that every pound of pentane so transformed produces 10,000 lb. calories of heat.

The immediate effect of this production of heat is to increase the velocity of the flying molecules. The actual velocity of the products of combustion in the vessel depends on the mean temperature. Direct measurement of the temperatures of the working charge of a gas engine gives 2570° abs. as a reasonable temperature from which to calculate molecular velocities. At this temperature the carbon dioxide molecules are moving at 3950 ft. per second, the steam molecules at 6166 ft. per second, and the nitrogen molecules at 4950 ft. per second; these numbers being the square roots of the mean squares of the actual velocities.

The next point for consideration is the time taken to effect this change. The time-interval taken by oxygen to combine with carbon and hydrogen lies along a time scale beginning with a detonation and ending with slow burning. In a mixture of air and pentane the oxygen molecules are a long way, on the average, from the carbon and hydrogen of the pentane molecule, and also the freedom of action of the oxygen molecules is clogged by the inert nitrogen present, but the rapidity with which oxygen can combine when the circumstances are favourable is shown by nitro-glycerine.

Chemists have discovered how to produce this nitro-glycerine molecule so that oxygen lies side by side with the carbon and the hydrogen. Its action is unclogged by any other substance, and the molecular distances have been annihilated, or perhaps it would be better to say that they have become atomic distances. Moreover, the molecule contains almost the exact quantity of carbon and hydrogen required to satisfy the oxygen present. As Lord Moulton once put it, it is a case of the lion and the lamb lying down together. A mechanical shock causes an immediate transformation—the lion devours the lamb; and the time-interval for the meal is so short that it is not measurable. This is called a detonation. Chemists have by their researches shown how to combine nitro-glycerine with other substances in order to control the rate of combustion. Engineers are also trying to get control of the rate of combustion of some of the mixtures used in the internal combustion engine. Thus the chemist and the engineer are working in different parts of the same wide field of research.

Experiments initiated by Sir Dugald Clerk are now proceeding at the National Physical Laboratory under the general supervision of the Aeronautical Research Committee for the Air Ministry. Apparatus of the most refined nature has been devised, and the research is being carried out by Mr. Fenning. Various combustible mixtures are made up in a bomb. These are exploded and then the time taken for the chemical combination to take place is recorded. Two results may be mentioned: a mixture of one part by volume of hydrogen, $2\frac{1}{2}$ parts by volume of air, was compressed to 64 lbs. per sq. inch and then exploded. Between the passage of the spark and the beginning of the rise of pressure about four-thousandths of a second elapsed. The combination was complete in about the same interval of time. In another experiment the mixture was diluted with one part of hydrogen and 6 parts of air; this caused delay in the combination, which took six-hundredths of a second to complete. In such diluted mixtures the energy has to be shared by all the molecules which do not take part in the change.

The engineer is faced with two problems: the problem of a too rapid combustion, becoming a detonation, and the problem of a combustion too slow for complete combustion at high speeds.

In practice the turbulence and eddies caused by the rapid admission of a charge through the narrow annulus of an open admission valve results in quickening the rate of combustion, and it is owing to this cause that the gas engine can run at speeds greater than those corresponding to the measured rate of flame propagation for an efficient mixture. Sir Dugald Clerk found a striking difference in the area of indicator diagrams according to whether the mixture was exploded immediately after the admission valve was closed or whether it was exploded after precautions had been taken to damp out the eddies.

Among the problems arising from running internal combustion engines at high speeds is that of torsional oscillations, and synchronous oscillations. There is also the balancing problem. The four-cylinder petrol engine is usually constructed so that it is perfectly balanced for primary forces and couples, but gives the maximum error for unbalanced secondary forces. At certain speeds a model of this type suspended from springs will oscillate twice as fast as the speed of rotation of the engine, while at the same speed and on the same springs a model, balanced to eliminate the secondary forces, will run steadily at all speeds.

Other problems have also to be considered. Accurate records of the pressure-volume relation in the internal combustion engine must be obtained, and the difficulties are increased owing to the high speed at which the cycles take place. The direct measurement of temperature is also a difficult matter, and there are various fuel problems.

Sufficient has been said to show that the future of the internal combustion engine is not settled; it is full of problems requiring continuous and laborious research. The question is what provision has been made for this research. Before the war purely scientific research on the internal combustion engine was focussed largely in the Research Committee of the British Association established at the Dublin meeting in 1908. This Committee was the only one of its kind, and the work was carried on vigorously until the war under the successive distinguished chairmen, Sir William Preece and Sir Dugald Clerk. The Committee is still in existence. There is also the Research Laboratory at Shoreham under the direction of Mr. H. R. Ricardo, himself a distinguished scientific investigator.

During the war official organisations have been established, and now the Department of Scientific and Industrial Research provides aid in money, apparatus, advice, and encouragement to any individual worker who has ideas and is qualified to carry on a research alone or under direction. This is a great national asset. But above all, so far as the petrol engine is concerned, there is the powerful organisation for Research within the Air Ministry itself, generally under the supervision of Air-Marshal Sir Geoffrey Salmond (known as the Director-General of Supply and Research), but under the immediate direction of Brigadier-General Bagnall-Wild, officially known as the Director of Research. The Air Ministry is advised by the Aeronautical Research Committee under the chairmanship of Sir Richard Glazebrook. This Committee has grown from the old Aeronautical Advisory Committee of the late Lord Raleigh. Work of the highest scientific value is now in progress at the National Physical Laboratory, at Farnborough, and at other places under the direction of the Ministry.

All I have done here is to hint at some of the work now going on at the National Physical Laboratory; it would take a whole evening merely to epitomise the researches in progress at that institution. Farnborough is now entirely a research establishment in its widest sense, for it is organised both for laboratory and for full-scale work. Work on the internal combustion engine has reached a magnitude and an intensity undreamt of before the war. The war has, in fact, shown that the internal combustion engine instead of being a convenient prime mover to put in our motor cars, to drive our workshops, or even our ships, has become an engine vital to our very existence. The Aeronautical Research Committee realises this, and the Air Ministry also. Let us hope that the nation will realise it too, and that in the need and passion for economy our legislators will not starve research on this vital national prime mover.

The Hull Meeting of the British Association.

Local Arrangements.

ARRANGEMENTS are well in hand in connexion with the meeting of the British Association for the Advancement of Science at Hull, September 6-13. Hull is particularly well provided with suitable rooms for the evening discourses, public lectures, and sectional meetings. Its large City Hall, centrally situated, accommodates three thousand people, and trams for every part of the town start at its doors. In this the inaugural meeting on Wednesday, September 6, will be held at which Sir Charles S. Sherrington (President of the Royal Society) will deliver his presidential address entitled "Some Aspects of Animal Mechanism." On the following day the City Hall will be the scene of the Lord Mayor's reception.

Hull's new magnificent Guildhall provides an excellent reception-room, adjoining which the banqueting chamber makes a very fine lounge and writing-room. On the same floor are suitable rooms for the various officers of the Association, the press bureau, the meteorological demonstration given by the Air Ministry, etc. This last named will be very welcome in the reception room, where it will be seen by everybody, and in an adjoining room the methods of preparing the chart will be available to the members.

Across the road from the reception-room are the British Association refreshment rooms, the Queen's Hall (Section F (Economics) and joint meetings). Section A (Mathematics) meets in the Central Hall, Pryme Street; B (Chemistry) in Waltham Street; C (Geology) and H (Anthropology) in the Museum and Royal Institution; D (Zoology), E (Geography), K (Botany), and M (Agriculture) in the new Art School; I (Physiology) in the Church Institute; J (Psychology) in the Albion Hall; and L (Education) in the Lecture Hall, Jarratt Street. All these buildings are within three minutes' walk from the terminus of the various tram routes in the City Square.

The Local Committee is providing each member with a small badge, which has been artistically designed and will serve as a more convenient means of identification than the somewhat cumbersome members' ticket (this latter, however, is this year to be waistcoat-pocket size and once more includes, as formerly, a map of the meeting-rooms). Each badge bears the number of the member's card, so that a reference to the index at the end of the list of members will enable the identity of any particular member to be ascertained, if desired.

With regard to the accommodation, while it is not expected that there will be any difficulty in providing for as many members as care to visit the city, the hotel accommodation which will be available for visitors is exceedingly limited. This year, therefore, a list of hotels and lodgings will not be prepared, but a special committee is sitting with the object of meeting the requirements of the members. In this connexion rooms are being provided at Bridlington, Hornsea, Withernsea, Beverley, Cottingham, Brough, Ferriby, Hessle, and other places in the immediate vicinity, but the provision of special late trains and of exceptionally favourable weekly contract tickets for this meeting will help considerably. It is desired to impress upon intending visitors to the Hull meeting the necessity of filling in the cards on the back of their preliminary programme, and returning them to the Secretary at the earliest possible moment, in order to prevent unnecessary trouble, which will certainly be caused if members arrive at the meeting without having previously notified their intention of being present. This warning seems particularly necessary, as several members have intimated their intention of being present, but neither state that they have found accommodation nor that they wish accommodation to be found for them. Those who have applied will receive particulars of their rooms shortly.

In a previous article reference was made to the various presidential addresses, with the exception of

Section J (Psychology), which was to have been by the late Dr. W. H. R. Rivers. We are now pleased to announce that Dr. C. S. Myers has accepted the presidency of this section and will deliver an address on "The Influence of the late Dr. W. H. R. Rivers on the Development of Psychology in Great Britain."

An exceptional opportunity at the Hull meeting will be afforded for discussing thoroughly the work of the Corresponding Societies of the Association. This subject has had the serious consideration of the council of the British Association for some time, and at the Hull meeting it is proposed to depart from the practice which has grown up in recent years of looking upon the Conference of Delegates almost in the light of still another section of the Association, and to revert to the former system of discussing the various ways in which the corresponding and other local societies may accomplish useful work. Conditions which obtained since the war are likely to interfere with the work of natural history, geological, archæological, botanical, and allied societies; already the publication of the results of their work has been seriously impeded by the present charges for printing, and in many other ways it seems desirable that this Conference of Delegates shall be more of a conference than of a Section X, to which papers, not quite desired by other sections, shall be sent! Certainly in recent years the connexion between the Conference of Delegates and some of the papers presented at its meetings has been somewhat remote. At Hull, therefore, there will be no set presidential address to the conference.

Advantage will be taken of the fact that the meeting is held in the county in which probably the leading provincial society in the British Isles (that is, the Yorkshire Naturalists' Union) exists, and the way in which this society, by means of its sections, committees, publications, etc., carries out and records its researches will be explained in Hull, as probably upon such lines it will be necessary that other societies should work in the future.

The list of the distinguished members from the near continental countries, from the United States, Canada, and other parts of the world, is constantly growing, and the Hull meeting bids fair to be memorable from the part these gentlemen will take in its proceedings.

Under the editorship of one of the local secretaries a handbook to Hull and the East Riding of Yorkshire is in preparation, and will be presented to each member. In this booklet an effort will be made to direct attention to the various attractions in the Riding, as well as to give descriptions of the city and district under the heads of geology, zoology, botany, archæology, meteorology, commerce, etc.

Elaborate arrangements are being made by a special excursions committee for general and popular excursions to Scarborough, Flamborough, Bridlington, York, Beverley, and other places of scientific interest within easy access of the city, as well as for special excursions of smaller parties of members particularly interested in geology, engineering, chemistry, and other subjects.

In addition to the handbook, a local programme is in preparation, which will contain particulars of the various directions in which the members may be occupied during their stay in Hull. The Constitutional Club, the East Riding Club, and others are electing members of the British Association honorary members of the clubs during the meeting, the Freemasons are giving a reception to their brethren, and special exhibitions of various kinds are being prepared to interest the different sections of the Association. One of these, organised by the Yorkshire Naturalists' Union, will be held in the Board Room of the Education Offices opposite the Museum in Albion Street, and will illustrate the work of the various sections and committees of that society.

The public lectures to citizens so far arranged are as follows:—Dr. A. Smith Woodward on "The Ancestry of Man"; Dr. E. H. Griffiths on "The Conservation and Dissipation of Energy"; Sir Westcott Abell on "The Story of the Ship"; Prof. A. P. Coleman on "Labrador"; and the Rev. A. L. Cortie, S.J., on "The Earth's Magnetism."

Evening discourses will be given by Dr. F. W. Aston on "The Atoms of Matter, their Size, Number, and Construction," and by Prof. Walter Garstang on "Fishing: Old Ways and New."

For the first time, special lectures are being arranged for the children in the upper classes in the secondary and other schools in the city, and these will be given by Prof. H. H. Turner on "The Telescope and what it tells us"; Prof. J. Arthur Thomson on "Creatures of the Sea"; and Mr. F. Debenham on "The Antarctic." Each lecture will be given to two thousand pupils. T. S.

Current Topics and Events.

AN imposing gathering of savants recently assembled in the great hall of the Sorbonne to celebrate the double centenary of the foundation of the Asiatic Society and the discovery by Jean François Champollion of the secret of the Egyptian hieroglyphs, the most important of which is the famous Rosetta Stone in the British Museum. The meeting, presided over by M. Millerand, was addressed by M. Sénart, who pointed out that the Asiatic Society was founded at the period when Champollion, in his famous letter to Dacier, revealed the secret which restored to humanity five thousand years of history. Since then the Society had always been in the van of Orientalism, and Phœnician and Palestinian epigraphy and archæology owed it a lasting debt.

SIR ARTHUR EVANS, in the *Times* of July 14, announces two dramatic discoveries at Knossos. It had long been observed that the position of the walls at the South-east Palace angle indicated a sudden collapse of the building by what could only have been a great earthquake shock. The discovery of two large skulls of the urus ox, and in front of them, remains of portable terracotta altars, showed that "previous to the filling in there had been a solemn expiatory sacrifice to the Powers below—recalling the words of the Iliad, 'in bulls doth the Earth-shaker delight.' There can be little doubt that the great deposits throughout a large part of the Palace area, all illustrating an identical cultural phase and indicative of a widespread contemporary ruin about 1600 B.C., were due to the same physical cause. The great earthquake of Knossos, in fact, sets a term to a Minoan period." Even more dramatic than this is the discovery on the South side of what appeared to be the opening of an artificial cave, with three roughly cut steps leading down to what can only be described as a lair adapted for some great beast. "But here perhaps," says Sir Arthur Evans, "it is better for imagination to draw rein." Was this really the abode of the Minotaur?

A BIOLOGICAL expedition is leaving Antwerp for Brazil during this month. It is under the direction of Prof. C. Massart, of the department of botany in the University of Brussels, and there are four other members of the expedition, two of whom are students. For several years before the war the universities of Belgium and Holland organised expeditions to enable students to go into the field under the guidance of their professors, and it is one of these expeditions, to Brazil, which has now been promoted by the University of Brussels. The party will not aim at exploring Brazil; the object is rather to put the young naturalists directly in touch with tropical Nature; they will have the opportunity of collecting botanical and zoological material for study and demonstration and of making ethnological observations. Brazil has been chosen on account of its salubrity and also because, some twenty days' journey from the starting-place, the party will be in the virgin forest. The expedition will remain in Brazil from August until January or February next, and visits will be paid to the States of Rio de Janeiro and Bahia, to the Campos de Minas Geraës, a region in the State of Bahia which is almost deserted, and to some of the peaks of the Serra de Mantiqueira. The necessary financial support for the expedition has been assured by the University of Brussels and the Belgian Ministers of the Colonies and of Sciences and Arts, while the Brazilian Government has promised every assistance for the success of the expedition.

THE American Museum of Natural History has recently received from Mr. J. D. Rockefeller, jr., a gift of a million dollars—the largest single donation that has ever come into its exchequer. It is the result of a long and careful inquiry which the donor has caused to be made into the value of the work done by this institution in connexion with the public schools. At the same time, Mr. George F. Baker, a leading New York banker, has given a quarter of a million dollars to the museum. The income from these gifts may be used to extend the direct educational work of the museum, or to assist its research expeditions. The most important of these enterprises being carried on at present is the sending of a party, with specially constructed automobiles, to penetrate the Great Mongolian Desert, a tract which is almost virgin soil for the archæologist and palæontologist.

A NOTE is given in the *Meteorological Magazine* of June from Mr. R. C. Mossman on some recent remarkable temperatures. At Buenos Aires, on the morning of April 26, the shade minimum fell to 27°·9 F. and the grass minimum to 20°·5 F. The previous April shade minimum in the last 60 years was 33°·4 F. On March 10, at Grytviken (South Georgia), the shade maximum rose to 83°·8 F., which is 13° above the previous record.

SIR WILLIAM POPE has been elected president of the International Union of Pure and Applied Chemistry for the ensuing three years. The next meeting of the Union will be held at Cambridge in June 1923.

PROF. A. N. WHITEHEAD has been elected president of the Aristotelian Society for the coming session; he will deliver his inaugural address on November 6.

THE annual meeting of the French Association for the Advancement of Science will be held at Montpellier on July 24-29 under the presidency of Prof. Mangin, director of the Paris Museum of Natural History.

AT the annual general meeting of the Royal Society of New South Wales on May 3, Mr. C. A. Sussmilch was elected president. Mr. Sussmilch is principal of the Newcastle Technical College (N.S.W.), and was for many years lecturer-in-charge of the Department of Geology and Mining, Sydney Technical College. His contributions to science include an account of the geology of New South Wales and a number of papers on geology and physiography.

A MEETING of the Royal Meteorological Society will be held in the Rooms of the Royal Society, Edinburgh, on Monday, July 24, at 3 o'clock, when the following papers will be read: "Observations of Upper Cloud Drift as an aid to Research and to Weather Forecasting," C. K. M. Douglas; "Note on the Effect of a Coast Line on Precipitation," J. S. Dines; and "Note on Turbulence," illustrated by smoke and cloud photographs, Dr. A. E. M. Geddes and G. A. Clarke.

IN the Calendar of Industrial Pioneers in NATURE for June 24 it is stated that Singer, who died in 1817, was the inventor of the gold-leaf electrometer. Singer's invention of this instrument may have been independent, but the credit for its first invention belongs to the Rev. Abraham Bennet, who in 1789 included a description of it in his "New Experiments on Electricity." Mr. Shurlock, Principal of the Technical College, Derby, who has kindly pointed this out, says Bennet was a fellow of the Royal Society and for twenty-five years was curate of Wirksworth, Derbyshire, where he died, May 6, 1799, at the age of 49, but that little more is known of his career.

THE death of the eminent anthropologist, Dr. W. H. R. Rivers, has already been recorded in these columns. It will be satisfactory to his many friends, and to others who recognise his great services to science, to know that a full biography, with a complete list of his numerous books and articles, by

Dr. A. C. Haddon, his colleague in the Cambridge Expedition to Torres Straits, and Mr. F. C. Bartlett, appears in the July issue of *Man*. The bibliography of his published work between the years 1888 and 1922 is a remarkable record of the scientific knowledge and powers of work which this scholar possessed, and will increase the regret felt by all his friends and the students of his writings at his sudden and unexpected death in the plenitude of his activity.

At the first glance one might be tempted to remark that the science master has no concern with the teaching of English, but it is evident from the papers on the subject by Mr. Eggar and by Mr. Breames which have appeared in the *School Science Review* for June 1920 and 1922 respectively, that many science masters have to begin by teaching the boys who come to them to write English. We are told that boys of fourteen who have spent several years on the classical side of a public school are turned over to the science side unable to read English intelligibly or to write it in such a way that their meaning is clear. In such circumstances the science master's task is doubled. He must teach his boys the scientific and technical terms of his subject and also how to express themselves clearly and correctly. Mr. Breames divides the latter process into two stages. In describing an object or an experiment he trains his boys to devote one sentence to each feature or to each change. Afterwards he teaches them to combine into one longer statement the sentences dealing with the features or changes which are closely related. He finds that this procedure produces a "respectable style" of writing in about two years.

A booklet from C. F. Elwell, Ltd. (Craven House, Kingsway), shows one of the directions in which wireless telephony is developing, for we have illustrations of receiving sets made up into elaborate pieces of drawing-room furniture in the various period styles of decoration. The apparatus itself within these attractive coverings is in the form of compactly arranged enclosed standard panels, the simplest of which is equipped with a crystal detector. The more useful panels employ valve receivers, and the distance from which they will pick up messages, etc., can be extended by the addition of one or more panels of similar dimensions and appearance equipped with amplifiers. Either head telephones or loud-speaking apparatus can be used, and where the higher degrees of amplification are employed, an indoor loop aerial can replace the outdoor aerial which would otherwise be necessary.

Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, W.C.1, have sent us two catalogues just issued by them, namely, "College Text Books and Works of Reference on Science and Technology" and "Works on Medicine and Allied Subjects." As the lists are carefully classified they should be very useful for reference.

Our Astronomical Column.

It is stated in the *Times* that the proposal to remove the Paris Observatory to a new site is again under consideration. When the Observatory was erected it was outside the city boundaries, but to-day it is surrounded by busy thoroughfares and streets of tall houses. Commenced in 1667 and finished in 1671, a few years before the Greenwich Observatory, the main buildings, as seen to-day, were designed by Claude Perrault, the famous architect of the Louvre. The first director was Dominique Cassini, who had come to France in 1669 at the invitation of Louis XIV., and the directorship remained in the Cassini family for about 120 years. Picard and La Hire were among the first to work in the Observatory, and Grant, in his "History of Physical Astronomy," regrets that Picard's great merits as a practical astronomer were not recognised by his being placed at the head of it. The Observatory contains a fine collection of historical instruments and apparatus used by the distinguished astronomers and physicists who have laboured there, and once a month the public are admitted to see the Observatory and its treasures and to listen to short lectures on the instruments in daily use.

Cambridge University Observatory.—It is satisfactory to learn from the annual report of this Observatory, of which Prof. Eddington is director, that its activity, which was sadly crippled during the war, two of the assistants having lost their lives, is now fully re-established. The Sheepshanks equatorial is being used for photographic determinations of proper motion of faint stars by comparison of pairs of plates taken 15 or 20 years apart, one of each pair being photographed through the glass to permit of juxtaposition of images, film to film. The regions include those around stars investigated for parallax by Prof. Russell and Mr. Hinks from 1903 to 1905, also the region round θ Orionis, and Kapteyn's Selected Area No. 12. Some of the proper motions are being investigated by Miss Payne (Newnham). Miss Douglas (Newnham) is studying the relation between stellar velocity and absolute magnitude.

Mr. W. M. H. Greaves has been engaged on various gravitational researches, chiefly connected with the stability of Saturn's Rings, which have been published in the Monthly Notices of the R.A.S.

Harvard College Observatory's Report.—This is the first annual report issued since Dr. Harlow Shapley succeeded Prof. Pickering, who died in 1919, as director of this observatory. The report shows the wide, sweeping nature of the researches undertaken. Dr. Shapley and Miss Cannon have in hand a discussion of the distribution of stars of different spectral type and magnitudes which occur in the Henry Draper Catalogue. The investigations of stellar distances is another line of work in hand which will help in the study of the structure of the stellar system. Good progress has been made in the publication of the valuable Henry Draper Catalogue, and volume 97 has just been distributed. By the generosity of private donors the prompt appearance of the remaining volumes is now assured. Numerous discoveries as to stars with peculiar spectra have been made from an examination of the plates of the Henry Draper Memorial, among which the number of spectra having bright lines in the region of the Large Magellanic Cloud has been increased from 48 to 61. The Arequipa station is becoming yearly of more importance, and particularly so now when the distances of southern stars are so much required.

Research Items.

THE ART OF THE MARQUESAS ISLANDERS.—In 1595 the Spanish admiral, Alvaro de Mendana, discovered a group of islands about midway between the Peruvian coast and New Guinea, to which he gave the name of Marquesas, a shortened form of the name of his patron, the Viceroy, Garcia Hurtado de Mendoza, Marques de Canete. In the *Museum Journal*, issued by the University of Pennsylvania, Mr. H. Usher Hall describes a fine collection of the art of the islanders, including finely carved war-clubs, warriors' fillets, amulets made from cylinders of human bones, the war conch-shell, fans carved in whale ivory and wood. The human figures used in the ornamentation of canoes are particularly interesting. The article is illustrated by an exceptionally fine collection of photographs.

THE DEVELOPMENT OF FLINT IMPLEMENTS.—In *L'Anthropologie* (vol. xxxii. Nos. 1-2) M. A. Vayson, under the title of " L'Étude des outillages en pierre," publishes a valuable, well-illustrated article on the development of flint implements. Two principles which he lays down deserve attention: " La similitude des outils n'implique pas la communauté de races ou de civilisation de leurs fabricants; l'identité de forme des outils en pierre ne signifie pas l'identité d'emploi. Ainsi les similitudes vu les différences des outils en pierre que nous pouvons étudier ne permettent pas de conclure nettement sur leur emploi et sur les autres industries dont ils étaient auxiliaires."

A REMARKABLE PARASITE.—An interesting study of the flowers of the parasite *Rafflesia Arnoldii* is published by P. Justesen in Annales du Jardin Botanique de Buitenzorg, xxxii. Pt. 1, 1922. The observations were made on flowers and buds growing on " vines " in the highlands of Sumatra. The paper is illustrated by good photographs showing the form and structure of the large flowers; full measurements are also given of the mature male and female flowers. It is estimated that the complete development of a flower from a prominence just recognisable on a vine root occupies almost a year, and Mr. Justesen gives tables showing the increase in size of the buds during their development. Seven mature flowers were found—four female and three male. One of the female flowers, which is illustrated, measured 64 cm. across, but the largest was 72 cm., while the largest mature male flower measured 75 cm. in diameter. The author gives some details of the ripening of the seeds, which appear to take several months to reach maturity, and he has made some interesting observations as to their dispersion. The fertilisation of the diœcious flowers also presents some unsolved problems. The author suggests that the small seeds may be carried into the earth by termites, and that in so doing they may easily bring them into contact with the roots of the vines. He also suggests, from the finding of Rafflesia in widely separated areas which are nearly always just within the edge of primeval forest, and close to the tracks of pigs and other animals, that wild pigs, pangolins, and mice may be the agents for the wider dispersal of the seeds. A fine model of the flower of *Rafflesia Arnoldii*, which is the largest flower in the world, may be seen in Museum No. 1 at the Royal Botanic Gardens, Kew.

PHYSIOLOGY OF FUNGI.—In the Annals of the Missouri Botanical Garden (vol. viii. No. 3) appear two additions to the excellent series of studies in the physiology of fungi. The first, by G. M. Armstrong, is entitled " Sulphur Nutrition: The Use of Thiosulphate as Influenced by Hydrogen-Ion Concentration." Three fungi, *Aspergillus niger, Penicillium glaucum*, and *Botrytis cinerea*, were grown in various solutions containing different compounds of sulphur, and a study was made of the end products of thiosulphate and of its efficiency as a source of sulphur. Reversions of reaction from the more acid condition towards neutrality were observed with both Aspergillus and Penicillium. R. W. Webb, in his study of " Germination of the Spores of Certain Fungi in Relation to Hydrogen-Ion Concentration," finds that the majority of the fungi employed exhibit a distinct maximum of germination between P*h*. 3·0 and 4·0. It is not until P*h*. 1·5-2·5 is reached that inhibition of germination is evidenced. A study is made of the effect of different nutrient solutions such as Czapek's solution and solutions of mannite, peptone, and beet decoction, and curves of germination are given for different hydrogen-ion concentrations. In some solutions, *A. niger* and *B. cinerea* on germination produced no change in reaction, but in alkaline cultures of sugar-beet decoction caused a slight shift towards neutrality. The data presented by Webb are of considerable interest and importance and should be taken into consideration in any future study of fungicides or spray mixtures.

GIANTISM AMONG GASTROPODS.—The stories circulated of a gigantic gastropod in the Wealden strata of Sussex have been confirmed by Mr. B. B. Woodward in a paper on " *Dinocochlea ingens*, n. gen. et. sp." (*Geol. Mag.*, 1922, p. 242). A photograph is given of a specimen lying in calcareous sandstone of the Wadhurst Clay series, and it appears that this spiral object is the cast of a gastropod that sometimes attained a length (or altitude) of 2·22 metres (about 7 ft. 3 inches). The affinities of this giant are with the Tiaridæ. The shells are lost by solution, but the spiral casts show that they conformed to molluscan rules of growth. The whorls, some 23 in number, increase only slowly in size from the apex to the mouth, and the whole form is thus fairly cylindrical. Mr. Woodward shows how these objects differ from the concretions that occur in the same beds; but the seemingly abrupt appearance and extinction of Dinocochlea present a fascinating puzzle. The author reminds us that the Carboniferous *Actinoceras giganteum* may have been at least as large. The writer of the present note recalls the vertical cylindrical " concretions," some 10 feet in height, in the Potsdam (Upper Cambrian) sandstone of Blake's Quarry, near Kingston, Ontario, which he inclines to attribute to the burrows of gigantic worms. The notion has hitherto seemed fantastic; but surprises evidently await the palæontologist.

THE " TURTLE-OREODON LAYER " IN S. DAKOTA.—The Oligocene continental strata now under investigation by Princeton University in the Big Badlands of the White River, S. Dakota, afford an interesting parallel with the flood-deposits of Upper Miocene age which entombed the turtles of Old Castile (NATURE, vol. cviii. p. 481). Prof. W. J. Sinclair describes (Proc. Amer. Phil. Soc., Philadelphia, vol. lx. p. 457, 1921) how the remains of enormous numbers of land-turtles occur in all positions in the Oreodon beds, with skulls of mammals, bones gnawed by rodents, and coprolites of carnivores.

The assemblage is attributed to temporary floods sweeping across a surface on which the animals decayed. At several horizons in the Oligocene beds of Indian Creek Basin calcareous algal crusts have accumulated up to a foot in thickness, probably formed by a species of Cyanophyceæ.

PHOTOSYNTHESIS OF NITROGEN COMPOUNDS.—In a paper published in the June issue of the Journal of the Chemical Society, Prof. E. C. C. Baly, Prof. I. M. Heilbron, and Mr. D. P. Hudson describe the photosynthesis of nitrogen compounds from carbon dioxide and nitrates. It has previously been reported that decisive evidence of the production of formaldehyde by the action of light on carbon dioxide and water, in the presence of photocatalysts, had been obtained. It is now found that the "activated formaldehyde" so produced can react with potassium nitrate. This reaction takes precedence of the polymerisation of the activated formaldehyde to reducing sugars. When the activated formaldehyde is produced at a rate greater than that at which it can react with the nitrite and with the formhydroxamic acid thus formed, the excess polymerises to reducing sugars. In this case, the two reactions take place simultaneously and independently. Small traces of ammonia are frequently found in the solutions after exposure to light, and activated formaldehyde reacts with ammonia to give methylamine. This confirms Pictet's contention that formaldehyde acts in photosynthesis as a methylating agent. In the synthesis of compounds by the action of activated formaldehyde on formhydroxamic acid, oxygen is set free. The possible modes of formation of indole and quinoline compounds are discussed, and the paper is one which has great interest from the point of view of plant chemistry.

IRON ORE IN SOUTH AUSTRALIA.—The Geological Survey of South Australia has recently published in Bulletin No. 9 a very complete account of the iron ore resources of South Australia by R. L. Jack, Deputy Government Geologist. The iron ores of South Australia are of importance, first of all as a flux in smelting, particularly in smelting the silver-lead ores of Broken Hill; ultimately Port Pirie became the centre of this lead-smelting industry, and the bulk of the iron ore required was supplied from the important deposit at Iron Knob, which was acquired by the Broken Hill Proprietary Company. Subsequently this company took advantage of the large supply of good iron ore thus available to erect important iron and steel works at Newcastle, New South Wales. These steel works were started in 1915, and the South Australian production of iron ore went up at once from a little more than 37,000 tons to nearly 265,000 tons, while in 1921 it reached nearly 629,000 tons. Since 1919 the value of the iron ore produced has exceeded that of any other mineral product. A very large number of deposits of iron ore are described in this Bulletin, though it is obvious that the two groups, Iron Knob and Iron Monarch, with estimated reserves of 133 million tons, and Iron Prince and Iron Baron, with estimated reserves of 32 million tons, overshadow all the others in importance. Since South Australia possesses no fuel supplies for metallurgical purposes, the iron ore production is necessarily for export, and on this account the accessibility of a deposit of iron ore in South Australia forms an essential element in determining its economic importance; due regard has been paid to this point in describing the various deposits, stress being laid on those that are well suited for export purposes.

FORMATION OF THUNDERSTORMS. — Mr. E. V. Newnham, of the Meteorological Office, has contributed a discussion, Professional Notes, No. 20, on the formation of thunderstorms over the British Isles in winter. Thunderstorms are rare in winter over eastern England, but they occur more frequently in the west and north. In January during the eight years discussed, 1900–1907, storms occurred on one or two days only, on the east coast of England, but on 19 days at Blacksod Point, 14 at Stornoway, and 11 at Valencia. Forty years ago Dr. Buchan showed that thunderstorms were quite common in winter in the west of Scotland but were very rare in the east. The author has attempted to explain the cause of the winter thunderstorms, following the reasoning generally admitted for the formation of thunderstorms in summer, namely, instability of the air with height caused by a rapid fall of temperature. He attributes the instability in winter to the heat imparted to the lower layers of cold air currents in disturbances which have come from cold northern regions and have subsequently travelled over a considerable area of the warmer ocean. Maps are given showing the trajectories of the January storms he has discussed. It is shown that when a thunderstorm occurred with a south-west or west wind the origin of the air was nearly always in higher latitudes, and air which traverses a long stretch of ocean seldom occasions thunderstorms unless it has come from very cold regions, but with these conditions thunderstorms usually occur.

A DIRECT-READING SPECTROMETER.—The Government Laboratory exhibit at the Royal Society Conversazione on May 17 included a new type of direct-reading spectrometer made by Messrs. Bellingham and Stanley, Ltd., which embodies several novel features. The optical arrangement is shown in Fig. 1. The light entering through the slit 1 is reflected

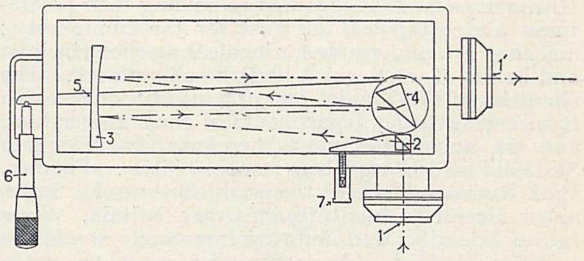


FIG. 1.

by a small right-angle prism on to a concave mirror 3, which directs a parallel beam of light on to the dispersing prism 4. The prism reflects the beam back to the concave glass mirror which brings it to a focus in a plane on the slit 1'. The dispersing prism is mounted on a rotating table which may be turned by the arm 5 operated by the micrometer screw 6. The screw head is divided so that it can be set to pass any particular wave-length of light to slit 1', and thus the instrument can be used as a monochromatic illuminator. For investigations in the ultra-violet the glass prism 4 is replaced by one of quartz, and the mirror is of quartz with mercury tinfoil amalgam backing. When in use as an infra-red spectrometer the dispersing prism is of either quartz or rock-salt. The chief advantages of this design are that the 30° prism is always used in the position of minimum deviation, and that with the concave mirror no chromatic differences of focus are introduced.

Glasgow Meeting of the Society of Chemical Industry.

THE forty-first annual meeting of the Society of Chemical Industry, which was held in Glasgow on July 4-11, was the fourth occasion on which the Society has visited Glasgow, the last visit being in 1910. Last year the Society met in Canada, under the presidency of Sir William Pope, and at this year's meeting it has been honoured by the presence of its Canadian president, Prof. R. F. Ruttan, of McGill University, Montreal, with a party of visitors from Canada and the United States.

The president addressed the Society on "Some Aspects of Scientific and Industrial Research," and, after referring to the influence of the war in directing academic research into industrial channels, spoke of the lesson of co-operation which had thereby been learned, and the prominence now being given to internationalism in science. This was expressed notably in the establishment at Brussels in 1919 of the International Research Council of the Allied and Neutral Nations. The Council includes the International Union of Pure and Applied Chemistry, and its ultimate goal is to make a World Parliament of Sciences. This organisation, said the president, should do more than any other for the unification of mankind, because its underlying principle is the universalism of science and the catholicity of truth. The organisation in Great Britain of a State Department of Scientific and Industrial Research has given rise to similar Departments in the Overseas Dominions and the United States. In consequence, a dearth has been revealed of men sufficiently trained and laboratories suitably equipped for research. One of the first problems to be faced by the research organisations is how permanently to associate those pursuing abstract science with those concerned with its application. Universities must be regarded as holding their laboratories and equipment in trust for the community; and they are responsible for inculcating the principles and habits of work which underlie all research. The countries of the Empire expect capacity for research from the scientific departments of their universities, and the universities must therefore have adequate State aid to discharge these responsibilities. Further, Prof. Ruttan advocated the establishment of a State-aided Research Institute in Great Britain, where future scientific and industrial research would be suitably blended. A compromise must be made between scientific ideals and industrial needs; and scientific research should become an accepted responsibility of the State, as certain and permanent as that of national education.

A noteworthy feature of the present meeting has been the inauguration of the Messel Memorial Lectures, established by means of a legacy to the Society of Chemical Industry by the late Dr. Rudolph Messel, which was to be applied for "... the furtherance of scientific research and such other suitable objects as the Council of the Society may determine." The first Messel Medal was presented to Prof. H. E. Armstrong, who delivered a lecture entitled "Rhapsodies culled from the Thionic Epos."

The title of Prof. Armstrong's lecture is explained by the fact that Dr. Messel was the pioneer in the manufacture of sulphuric anhydride by the aid of a platinum catalyst. Besides discussing the mechanism of catalysis and the influence of water in chemical change, the lecturer made an earnest plea for clear thinking in science, for free criticism and exchange of opinion, and for the development of a philosophy of science based on experience. Prof. Armstrong said he was glad that, after the great attention which had been paid to the physical aspects of chemistry, a return was now being made to the consideration of molecular structure, and the inner meaning of chemical phenomena. Advance in the domain of organic chemistry has outstripped that in other branches, because in them there had been little effort to develop a theory of chemical change on the foundation laid by Faraday.

Papers were read by Dr. J. W. M'David on "A Rapid and Accurate Method for the Calibration of Storage Tanks," a method which depends on the time taken to fill the tank to a given level by water forced through an orifice by a constant head; and by Dr. R. A. Joyner on "The Viscosity of Cellulose in Cuprammonium Hydroxide," a novelty described being the preparation of the reagent by dissolving finely divided copper in aërated ammonia solution.

The remaining papers of scientific interest were provided by the Engineering Group, which, in its fifth conference under the chairmanship of Mr. J. A Reavell, considered the subject of evaporation and distillation.

In an introduction to an abstract of the papers the relation between evaporation and distillation with reference to modern types of plant was emphasised. Mr. P. Parrish presented a paper on the design of ammoniacal liquor stills, in which the origin of the present type of still was traced, details of the composition of ammoniacal liquor were given, and the distinguishing features of the various kinds of still were discussed, together with the physico-chemical principles involved in their use, and the probable lines of future development. Mr. W. A. Walmsley dealt with tar distillation. In this paper the differences in composition between tar from horizontal and from vertical retorts were considered, and details were given of experiments on the continuous distillation of tar, which yields a greater output than the intermittent process. The treatment of tar fractions was outlined, experiences with modern distilling columns were described, and lines of desirable progress suggested.

The general problem of evaporation was reviewed by Prof. J. W. Hinchley. The influence of various conditions of temperature, atmospheric pressure, and hygroscopic state, radiation, and air-contact upon evaporation was considered. Appropriate evaporation formulæ were developed, their application to details of engineering design was discussed, and their economic importance emphasised. Mr. T. H. Gray read a paper on the historical development of the distillation of glycerine in which interesting drawings of plant were submitted. The importance of economic working was pointed out and the high state of purity of the modern product emphasised. The value of all these papers was much enhanced by the discussions by which they were followed.

A handbook of the meeting had been prepared by the local secretary, Dr. J. A. Cranston, which contained a useful account of the chemical and allied industries of Glasgow and the West of Scotland, prepared by Mr. W. H. Coleman.

R. M. C.

The Development of Research in Universities.[1]

By Principal IRVINE, F.R.S., Vice-Chancellor of the University of St. Andrews.

FOR some years it was my privilege to direct the work of a research laboratory where young graduates were trained in research methods and, after a period of collaboration, enabled to strike out independent lines of inquiry for themselves. This endeavour to make research work an organised part of the university's activities was successful, and it occurs to me that the experience thus gained in miniature may be of service in discussing the larger problems associated with the development of research in all subjects, in all universities.

It is not necessary to defend here the idea that research is a vital necessity. My plea is that, although much has been done, our research efficiency as a nation can be vastly improved and the full advantage reaped from present expenditure by changes which in themselves would not be expensive. The functions of a university are threefold: to satisfy the intellectual needs of the people, to lead the communities we serve, and to add to the store of human knowledge. Yet it must be emphasised that every advance made by investigation is something more than a mere addition to knowledge; it means also that some one has gained a rich experience. It is not so much the prize as the discipline of training and the joy of supreme effort which makes any contest worth while, and this applies equally in the world of intellect as in the realm of sport. The universities should not leave original research to the solitary worker, to the unaided enthusiast, but must place facilities for research in the way of every one naturally equipped with the spirit of inquiry.

These ideas are widely spread and are all but universally accepted. The movement in favour of the research development in the universities has suddenly taken shape after many years spent in educating public opinion. Glance for a moment at the phases through which it came into being. In doing so I confine myself meanwhile to research in experimental science, where development has been most rapid and is most easily traced.

I commence with the institution of the 1851 Exhibition Research Scholarships, a wise step which placed at the disposal of a few selected graduates the means necessary for extending formal study by research work.

On this was modelled some nineteen years ago the research scheme of the Carnegie Trust which has done so much to improve the efficiency of the Scottish universities. Whatever views may be held regarding the payment of university fees by the Carnegie Trust there can be only one opinion as to the wisdom and success of this feature of their activities. Notice the points of distinction between the Carnegie Trust Scheme and that of the 1851 Exhibition Commissioners. The latter is confined to scientific subjects alone, and, until recently, scholarship awards were made on one uniform standard. On the other hand, the Carnegie Trust also opens the door to literature, language, history, and economics. The award begins with a scholarship, and from this the best scholars are promoted to fellowships and ultimately to research assistantships, which include teaching duties. There is thus a steady weeding-out process at work, and only the best survive.

[1] From an address on "The Need for the Provision of Enlarged Opportunities for Advanced Study and Research in the British Universities," delivered at the annual Conference of Universities of Great Britain and Ireland, held in London on May 13.

There are, of course, other research organisations operating in the universities, but I may pass at one step to the national scheme now administered by the Department of Scientific and Industrial Research. The details of this scheme follow closely the lines adopted by the Carnegie Trust for the universities of Scotland, but differ in the exclusion of non-scientific subjects.

I question very much if the full measure of advantage afforded by these schemes could ever have been attained if the universities had not taken the common action of instituting the Ph.D. degree. Now we are launched on this great new effort. The word "research" is on every tongue. In many subjects of study provision has been made for financing the way to research, and the universities have recognised the movement by the award of the new doctorate. What obstacles and difficulties have already been encountered and what have we still to guard against? These are among the questions I try to answer from an experience admittedly incomplete. Let us take the features common to all universities, irrespective of size or location, and to all subjects of study. The first urgent need I perceive is that our research organisation must recognise the claims of three distinct classes of original workers. These are: First, the young graduate, attracted sometimes by the genuine spirit of research, sometimes by less worthy motives, who in practically all cases is immature and untrained. Then there is the second class, represented by the university lecturer who has passed the apprentice stage and couples with teaching duties the continuation of his researches, frequently through love of the work, sometimes through recognition that worldly wisdom and the hope of a chair make it advisable. In the third place, we have the mature worker and thinker, represented by the professor, the man whose experience is ripe but whose time, already getting short, is fully occupied with other things.

Each class merges into and feeds the other, and all three classes need help. Prudence points to using the mature material to the best advantage, yet we have never done so, and the research schemes of to-day make the situation infinitely harder than before. The bulk of support is now afforded to the graduate research worker. Scholarships are awarded generously and widely. The conditions attached are moderate and reasonable, and there is now a rush to research. But the young worker has to be trained, supervised, guided, inspired, and this help can come only from the members of my two upper classes—the lecturers and the professors. I wish specially to emphasise this necessity, for I have seen too many good research workers spoiled and discouraged through lack of help, and too many moderate workers developed into investigators of the first rank by careful guidance. Such supervision and training involve the complete absorption of the time and energy of the mature investigator. There can be no formal course of instruction, no common course applicable to all pupils and all topics. Each individual has to be studied. There must be the daily consultations at the laboratory bench, in the library, and round the study fire.

The question of training and supervision must be taken seriously; there is a great danger, particularly in scientific subjects, that this has not been fully appreciated. How great is the temptation in such subjects to use the technical skill of the graduate to carry out one's own researches, to regard these young workers as so many extra pairs of hands. Even when the responsibility of becoming a research supervisor is fully recognised, how difficult it is to put oneself in the position of the beginner. The unexpected result is obtained, and the supervisor immediately explains it out of his long experience. What benefit does the student derive? The real supervisor has to curb his impatience and lead his collaborator to sum up the evidence and at long length reach the conclusion for himself. But that takes patience, sympathy, and, above all, time. The supervisor has his reward when gradually the research pupil reveals himself and emerges as an independent worker, but his own research output fades away. There is a novel called "The Devourers," in which a woman of genius finds her artistic development arrested when in time her children claim her every thought. Just as children are in this sense the devourers of their mothers, so are research students the devourers of their professors. When I relinquished my chair I was spending daily three hours at teaching and seven hours with the "devourers."

My first two points may be summarised thus:

(1) Research training must be thorough and must be taken seriously, both by the student and the supervisor.

(2) This training must be in the hands of mature investigators, who should be relieved of routine or administrative work and who need undertake only a limited amount of teaching.

This will cost money, and staffs must be enlarged to supply the main bulk of routine university teaching. There is plenty of room in university organisation for the patient conscientious teacher on whom the gods have been kind enough to bestow only a modest passion for inquiry. Nevertheless, the research supervisor himself must be a teacher and must mingle freely with undergraduates so as to recognise at the earliest possible stage the potential research workers of the future and to guide their studies accordingly.

The needs of the lecturer class of research workers are easily defined. They require more leisure for research than they get at present, and this freedom must not be secured through the agency of overwork and late hours. It should be defined and form part of the terms of appointment. So many hours in the day, so many days in the week, or weeks in the academic year, should be kept free from teaching or administrative work. Here again we encounter the question of finance. Additional staff must be provided, and for this more money is required. In this connexion the research assistantships recently instituted by the Carnegie Trust are a step in the right direction. One other point appeals to me strongly and involves no finance. Every facility should be given the lecturer-investigator to secure collaborators to work under him. I do not mean, of course, that the professor should take the pick of the bunch and leave the residue to his juniors. Every professor should pass a self-denying ordinance on himself in this matter, and, frankly speaking, he will find that it pays.

The professor's needs have already been dealt with, but there is another thing in which we can help him. Again it is a domestic matter. It is, I am convinced, a mistake for a governing body to call for an annual list of publications from their research departments. Nothing could be more injurious to the true atmosphere of research than the feeling of pressure; that papers must be published or the department will be discredited. Thus we have scrappy, incomplete accounts of topics which have been chosen apparently for no other reason than that results will come quickly. One point more regarding the professor: Let him have as much financial support for his work as can be spared, but it is well to insist on his keeping these accounts separate from those concerned with university teaching. But these are perhaps petty details compared with the greatest need of the professor-investigator—the necessity to be free at intervals to travel to other centres and refresh himself in the company of kindred workers.

What I have said appears to me to apply generally to all forms of university research and is founded partly on experiences other than my own. I turn now to concrete suggestions. The first and most important is that in each university there should be a Board or Standing Committee entrusted with the supervision of higher study and research. We have Entrance Boards, or Matriculation Boards, governing and regularising the first phase of university study, and it is equally necessary to have such a body assisting in the highest studies. The functions of such a body would be widely varied, and should include the power (1) to recommend additions to the teaching staff in departments actively engaged in research work and to recommend promotion; (2) to allocate money voted from university funds for research purposes, and to see that subjects which are denied benefits from Government or public schemes are properly supported (I speak more particularly on behalf of classical and philosophical subjects, which are in a serious position to-day); and (3) to supervise higher degrees, including approval of the topics given to students.

These need not be elaborated; but here are some specific needs which such a body at once encounters: (1) The provision of research libraries in which reference works can be consulted in the department where the work is carried out; (2) travelling grants to enable workers to visit libraries, to consult authorities, to inspect MSS., or carry out investigations in the field; (3) publication grants, so that where no periodical literature is available in which research results can be published, the work will not remain buried and obscure—the classical and philosophical workers in particular have difficulty in finding a publication medium; and (4) special assistance for subjects not included in National Research Schemes.

As a matter of practical convenience the policy of establishing separate suspense accounts for each of the above has been adopted in the University of St. Andrews, so that heavy expenditure in one year is balanced by accumulations.

An organisation such as I have outlined is, of course, open to some objections. Research cannot be machine-made; it cannot be governed by regulations or committees. The very word "research" is an expression of intellectual freedom. But some organisation is necessary. It is effected on lines similar to those sketched by the Carnegie Trust in Scotland and in miniature within my own university. The system works well in that the available money is fairly distributed without reference to utilitarian demands. All classes of research workers are stimulated by the feeling that their interests are being looked after and that no subject has preferential treatment. The classical scholar can work in harmony with his scientific brother and without a feeling of envy. Above all, it is a step towards the safeguard that all subjects of inquiry will be prosecuted in the universities, and we may be saved from the degradation of a one-sided intellectual development. The system educates even the mature investigator, and I am sure it is a good thing for the twentieth century chemist to learn something of, say, the social conditions of the twelfth. Then again, the danger is minimised that a young worker will be given, as is so often the case, an absurd problem, either fully explored, or hopelessly ambitious. In many branches of study the research enthusiasts have got their chance now, and they will have to work hard to justify it. The greatest need is money, so that all subjects may be helped, and our greatest difficulty will be to spend it wisely.

English Place-names.

At a meeting of the Royal Anthropological Institute held on June 27, Prof. A. Mawer, of the University of Liverpool, read a paper on "A Survey of English Place-names." He said that from the earliest times the value of place-names as a possible source of historical knowledge has been recognised. Much early history has frankly been invented from them, and historians have speculated freely as to their meaning. More recently, scholars like Kemble have seen the possibilities latent in place-names; but until Prof. Skeat first put place-name study on its only secure basis, namely, the study of the early forms of the names, most of the work in this direction was only idle speculation. Conducted on scientific lines, place-name study could do much to throw fresh light on the dark places in the history of our country and its civilisation, where we had no documentary evidence or only such as has long been worn threadbare. Place-names and archæology are the only unworked sources of evidence still remaining open to us, and these studies should be conducted in close touch with one another. With the aid of place-names, not only should we have fresh light on long-standing problems, but we should also be furnished with excellent illustrations of many phases of our history and culture.

At present we are only at the beginning of these studies. Much had been done by individual scholars upon single areas, but it has gradually come home to workers in this field that, in addition to such work, we also need co-operative effort, if ever we are to glean the true harvest of knowledge from place-names. The reasons for this are that (1) no safe inferences, either particular or general, can be drawn with reference to the names of any area except in the light of the full evidence for at least the whole of England; (2) the range of interests, historical, linguistic, topographical, and archæological, concerned in the problems of place-names is so wide that they could not be dealt with adequately by any single scholar. These considerations have moved a small body of scholars representative of the various interests named to initiate, under the patronage of the British Academy, a scheme for a survey of English place-names with a view, not only of the interpretation of the individual names, but also of drawing from them all that wealth of historical and cultural lore which is latent in them. During the first six months of work of the survey, a start has been made in several counties; many eminent scholars skilled in the various aspects of the work are giving active help, and close relationships have been established with the two public offices most immediately concerned in the matter, namely, the Ordnance Survey and the Public Record Office.

In opening the discussion, Mr. H. J. E. Peake expressed his gratification that the projected survey of English place-names was not to proceed upon purely linguistic lines, as had been done by earlier workers on this subject, but that archæological, historical and geographical evidence was to be taken into account. The organisation of local branches and local correspondents in this country which the Royal Anthropological Institute had just initiated, might well be of assistance in the work of the survey on these lines. In connexion with the survival of pre-Saxon elements in place-names, to which Prof. Mawer had referred as an instance in which archæological evidence might be brought to bear upon this problem, he indicated the possible connexion between the element "leck" (*e.g.* in Leckhampton) and a stone, monument or other, and between the element "wick" (*e.g.* Wickham) and Roman roads. The unknown site of the battle of Wodensburgh, wrongly identified with Wansdyke, to which Prof. Mawer had referred, he himself had identified by archæological evidence within the bounds of Aston Priors, the name possibly surviving in the neighbouring Woodborough. Dr. Singer emphasised the necessity for the study of anthropology of this country, as well as that of the primitive peoples of other parts of the world, to which attention had hitherto been too exclusively directed, and Mr. Nixon gave instances of explanations of Yorkshire place-names which he had obtained by investigations in Norway.

University and Educational Intelligence.

ABERDEEN.—The recent graduation ceremony on July 13 was one of the heaviest ever carried through; there were 224 degrees conferred, which included 101 in arts and education, 60 in science and commerce, and 57 in medicine. The special graduation of the previous week was devoted wholly to conferring the degree of LL.D. on ex-President Taft. The Vice-Chancellor, Sir George Adam Smith, presided on both occasions.

EDINBURGH.—Mr. J. A. S. Watson has been appointed to the chair of agriculture and rural economy in succession to Prof. Robert Wallace, retired. Prof. Watson was demonstrator in botany under Sir Isaac Bayley Balfour, afterwards continuing his studies in Germany, America, and Canada. He has been lecturer in agriculture in the University for some time.

At the graduation ceremony last week a "record" number of five hundred graduates were capped by the Vice-Chancellor, Sir Alfred Ewing. The B.Sc. degree in mining was conferred for the first time.

LEEDS.—Dr. W. MacAdam has been appointed medical tutor and registrar. Dr. MacAdam is a graduate of Glasgow University. He was awarded the Brunton Memorial prize as the most distinguished graduate in medicine of the year, and, after completing his University course, held the McCunn scholarship and the Carnegie scholarship in physiological chemistry. For two years he was senior assistant tuberculosis officer in Sheffield, and was at the same time a demonstrator in Sheffield University. He has been lecturer in pathology at the University and has held a number of medical posts. Mr. H. W. Symons and Mr. P. J. Moir have been appointed clinical assistants in surgery; both have been closely associated with hospital work for some years. These appointments, to new full-time posts, mark an important step in the development of the clinical teaching of medicine and surgery.

MANCHESTER.—The Council has appointed Prof. J. S. Dunn to the Procter chair of pathology and pathological anatomy in succession to Prof. H. R. Dean. Prof. Dunn at present holds the chair of pathology at the University of Birmingham. Mr. W. W. C. Topley has been appointed to the chair of bacteriology and to the directorship of the Public Health Laboratory. Mr. Topley is at present director of the Institute of Pathology and lecturer in bacteriology and pathology at Charing Cross Hospital, London.

IT is announced that Mr. R. M. Wilson, at present principal of the East Anglian Institute of Agriculture, Chelmsford, has been appointed principal of the South-Eastern Agricultural College, Wye.

THE Empire Cotton Growing Corporation will shortly appoint an assistant for cotton research in St. Vincent, West Indies, whose duties will consist of genetics research on the cotton plant. The salary offered is 600*l*.-700*l*., with free bachelor quarters. Further particulars are obtainable from the Secretary of the Corporation, Millbank House, Millbank, S.W.1. The latest date for the receipt of applications for the post is Thursday, August 10.

A NUMBER of evening advanced courses in technology are being organised as usual for the coming session by the University of Leeds. Students who are under the age of twenty-two are required to produce evidence of adequate preparation for the courses or to pass an entrance examination before they will be admitted. Courses are held in civil, mechanical, electrical, and gas engineering, coal mining, textile industries, colour chemistry and dyeing, leather industries, fuel, metallurgy and geology. Many of the courses are specially suitable for those desirous of undertaking research work.

Two Frecheville Research fellowships are being offered by the Imperial College of Science and Technology, South Kensington, to aid in carrying out any investigation or research connected with mining, mining geology, metallurgy, or the technology of oil, which, in the opinion of the Selection Committee, is of sufficient use or promise. Each fellowship will be of the annual value of 300*l*., tenable for one year, with a possible renewal for a second year, and the holder will be expected to devote his whole time to the work of the fellowship. Further particulars may be obtained from the secretary of the college, and all applications must be lodged with him before September 1, information being furnished at the same time as to the qualifications of the applicants and the nature of the proposed investigations.

THE president and council of the Royal Society propose to create a Foulerton Research Professorship and a Foulerton Research Studentship, the duties respectively of each being " to conduct such original researches in medicine or the contributory sciences . . . as shall be calculated to promote the discovery of the causes of disease and the relief of human suffering," and " to conduct researches in medicine or the sciences under the supervision and control of the managing committee." The annual value of the professorship will be 1400*l*. and that of the studentship 700*l*. Members of either sex are eligible for appointment. Applications must reach the Royal Society, Burlington House, Piccadilly, W.1, by, at latest, October 31.

THE West Indian Agricultural College, which has materialised as the result of the report of a committee on the question, referred to in NATURE of April 1, 1920, p. 153, will be opened in October next, in temporary accommodation which has been acquired at St. Augustine, Trinidad. Sir Arthur Shipley, who represents the University of Cambridge, is chairman, and Sir David Prain, representing with Mr. E. R. Darnley, the Secretary of State for the Colonies, deputy chairman of the governing body, on which will be also representatives of the University of Glasgow, the Royal Botanic Gardens, Kew, and the Imperial College of Science and Technology. The College will aim at providing a three years' diploma course in tropical agriculture for those desirous of following the business of tropical planting, and a shorter course for those unable to take the full course; there will also be facilities for research. Sir Francis Watts will combine the duties of Principal of the College and Commissioner of the Imperial Department of Agriculture, which has been amalgamated with the College. The College has offices at 15 Seething Lane, London, E.C.3, and further details of the courses can be obtained from the secretary, Mr. A. Aspinall, at that address.

PROF. ALEXANDER MAIR, writing in the Bulletin of the Association of University Teachers, says—" Research . . . is the fashionable cant word of our generation." He deplores " the fact that so many men and women . . . are induced to spend one or two important years in doing pedestrian work that could equally well be performed by an intelligent mechanic or clerk " owing to the fallacy that free creative activity can be commanded by a mere fiat. A similar warning is embodied in an article on Medical Research in the report for 1920–21 of the president of the Carnegie Foundation for the advancement of teaching. " Every college and university," he says, " covets the reputation of being a centre of research. . . . The result of this striving is that the thing which ought to be the greatest inspiration toward good teaching has become only too often an excuse to escape the primary duty of teaching." In Prof. Mair's article reference is made to " an inquest into the whole question " (of research by members of university staffs) which, it seems, the Association of University Teachers is undertaking.

THE retirement is announced, on the ground of failing health, of Mr. Sidney H. Wells from the post of Director-General of the Department of Technical Education of the Egyptian Government. Mr. Wells was appointed to that position in 1907 upon the creation of the department by Lord Cromer, and during his fifteen years' service has organised technical, agricultural, commercial, and industrial education in all branches. Generally speaking, schools of three grades in each of the sections named, elementary, intermediate, and higher, have been created, and there are now nearly fifty different institutions at work in the country extending from Alexandria to Assouan. With the creation of the Ministry of Agriculture, the direction of the agricultural schools was transferred to that Ministry, and it is intended to incorporate the Higher Colleges of Engineering and Architecture, and of Commerce, with the proposed new Government University of Cairo. For his work during the war as Director of Civilian Employment for the Egyptian Expeditionary Force, Mr. Wells was mentioned in Lord Allenby's dispatches and in 1919 was awarded the C.B.E. He also holds the insignia of Grand Officer of the Mejidieh Order, and of the Order of the Nile conferred by the Khedive Abbas and Sultan Hussein for his services to Egypt. Mr. Wells will be remembered as the first Principal of the Battersea Polytechnic, which position he held from the building of the institute until his departure for Egypt in 1907.

Calendar of Industrial Pioneers.

July 23, 1875. Isaac Meritt Singer died.—The story of the sewing machine is one of the romances of modern industry. To such as Thomas in England, Thimmonier in France, and Howe and Wilson in America are due the main features of the machine, but it was the Boston mechanic Singer who made it available for even the poorer people. Singer patented his machine in 1851; the Singer Manufacturing Company dates from 1863, while the annual output of machines rose from 21,000 in 1863 to 800,000 in 1896. To-day the Company produces more than 2,000,000 machines a year.

July 23, 1876. Henry Deacon died.—A successful industrial chemist, Deacon was born on July 30, 1822, in London, where at an early age he came under the influence of Faraday. He was trained as an engineer by James Nasmyth—for whom it is said he made the first model of the steam hammer—and afterwards became manager of glass works and chemical works. In 1855, with Gaskell, he founded the firm of Gaskell, Deacon and Co., manufacturing carbonate of soda, attacking the ammonia soda process, and taking out many valuable patents. With Gossage and Muspratt he was one of the founders of the prosperity of Widnes.

July 24, 1899. Sir Arthur Thomas Cotton died.—Like his contemporary, Sir Proby Thomas Cautley, Cotton was trained as a soldier but became a great irrigation engineer. He not only carried out many of the earliest and most important irrigation schemes in India, but he founded a school of hydraulic engineers, which is still engaged in the development of the resources of the Indian rivers.

July 25, 1843. Charles Macintosh died.—Born in Glasgow, December 29, 1766, Macintosh was enabled to attend Black's lectures at Edinburgh, and in 1786 he set up as a manufacturing chemist. In 1797 he started the first alum works in Scotland, and for many years was connected with Charles Tennant of the St. Rollox Works, Glasgow. His name is popularly known at the present time, however, for his invention in 1823 of a method of making cloth waterproof by cementing two thicknesses together with a solution of rubber in naphtha, an invention which, together with the discoveries of Goodyear and Hancock, laid the foundation of the rubber industry.

July 28, 1886. Sir John Anderson died.—An eminent mechanical engineer, Anderson was trained in Scotland, and after working with Fairbairn, John Penn, and David Napier was appointed in 1842 to Woolwich Arsenal, where he effected a complete revolution in the method of manufacturing guns and small arms, and ultimately became superintendent of machinery. He wrote a treatise on the strength of materials, lectured at the Royal Military Academy, and was officially connected with some of the great exhibitions.

July 29, 1708. Swalm Renkin died.—Known as the constructor of the famous "Machine de Marli," Renkin was born at Liége in 1644, and at an early age acquired a high reputation for his skill as a carpenter and millwright. Employed by Louis XIV. on the plans for conveying the water of the Seine to the fountains and works at Versailles, Renkin began the great machine in 1675 and completed it in 1682. The machine is said to have cost 8,000,000*l*. It consisted of 14 water-wheels driving no fewer than 253 pumps, some of which worked at a distance of three-quarters of a mile by chains and rods. The water was raised in three stages to a height of 533 feet, whence it flowed to Versailles by an aqueduct. This "gigantic specimen of a race of mechanical megalosaurians" was dismantled in 1817, and the water pumped by one of Watt's steam engines. E. C. S.

Societies and Academies.

LONDON.

Faraday Society, June 26.—A. W. **Porter** and J. J. **Hodges**: The law of the distribution of particles in colloidal suspensions with special reference to Perrin's investigations. Perrin found that the particles of a suspensoid distribute themselves according to the same law as the molecules in an atmosphere of gas; but his experiments extended over only a very small range of depth. Observations have been extended over a much greater range and wide divergence from the gas law is found; *e.g.* for the concentrations employed the concentration becomes sensibly uniform in a depth of one millimetre. Curves are fitted to the observations and the question is examined theoretically as well as experimentally.—W. R. **Cooper**: The electrochemical effects produced by superimposing alternating currents upon direct currents. Previous authors have shown that when an alternating current is superimposed on a direct current increased corrosion is obtainable and the overvoltage may also be reduced. It is now found that low frequency currents do not affect the amount of deposition or corrosion in the case of copper plates in copper sulphate. The view expressed by Goodwin and Knobel that alternating currents affect hydrogen overvoltage only when the conditions are such as to give a reversal of current in each period appears to be incorrect. The effect increases as the strength of the alternating current is increased, but the percentage effect becomes less, and takes an appreciable time to pass off when the current is discontinued. With platinum wire electrodes in dilute sulphuric acid, low frequency current gives the greatest effect when the applied voltage for the direct current is below the decomposition voltage, but this is not the case with high frequency currents. The absorption of hydrogen is very marked and there are other differences between the electrodes. If a fine platinum wire and a comparatively large platinum surface are used as electrodes, a high frequency current causes an electric discharge to take place under certain conditions. The resulting bubble forms in the body of the electrolyte, at a distance from the electrode, and the discharge is luminous in the dark.—T. M. **Lowry** and E. E. **Walker**: Expansion and shrinkage during caking of potassium carbonate. Photographic evidence is given of the expansion and subsequent shrinkage of an old package of potassium carbonate, after emptying out into a jar. Attempts to produce artificially such an expansion in various modifications of potassium carbonate have led to negative results. A possible explanation of the expansion assumes the presence in the material of a sesquihydrate, which expands on conversion into the dihydrate. Data are given in reference to the methods of preparation of this sesquicarbonate.—T. M. **Lowry** and L. P. **McHatton**: The powdering of minerals by decrepitation. The decrepitation of barytes may be attributed, as in the case of water-soluble salts such as lead nitrate, to the presence of included water; clear fragments have been obtained which are completely resistant to decrepitation by heat and a semi-quantitative relationship has been found between the water-content of barytes and the fineness of the powder produced by decrepitation. The decrepitation of celestine, crocoite, and common salt has also been investigated.—A. M. **Williams**: Two properties of powders. It is suggested that specific surface should be referred to unit mass and not to unit volume, owing to the relative difficulty of measuring the latter in the case of substances in a state of fine division. The heat of immersion is discussed and its relation to the apparent specific volume of a powder as obtained by the immersion method, and a new criterion to distinguish between a physical and a chemical change in certain cases is given.—J. L. **Haughton** and G. Winifred **Ford**: A note on the systems in which metals crystallise. In the majority of cases the system in which a metal crystallises depends on its position in the periodic table. Alloys which form a homogeneous series of solid solutions right across the diagram generally crystallise in the same system. There is apparently no relationship between the changes which occur in the physical properties of metals at the melting-point, and their crystalline habit. A possible exception is the electrical resistivity of the metals in the odd series of group 5.—A. J. **Kieran**: The electrical conductivity of hydrochloric acid and potassium chloride in presence of sucrose. The equivalent conductivities of hydrochloric acid, through a wide range of dilution, were determined in the presence of varying quantities of sucrose, the concentration of the latter being maintained constant in each series of measurements. While the behaviour of potassium chloride in presence of sucrose is normal, in that the equivalent conductivity increases regularly with increasing dilution of the salt to an asymptotic limit, that of hydrochloric acid is abnormal, the equivalent conductivity passing through a maximum and falling thereafter with increasing dilution. This is connected with the relatively minute traces of electrolytic impurity present even in the purest samples of sucrose obtainable. The nature of the abnormality is of interest in view of the close association of minimal amounts of electrolytes with other organic substances of high molecular weight.

PARIS.

Academy of Sciences, June 19.—M. Emile Bertin in the chair.—Marcel **Brillouin**: The isotropic field. Heterogeneous fluid sphere.—Maurice **Leblanc**: A new freezing machine with air as the working fluid. A detailed description, with diagrams, of a machine based on the principles given in an earlier communication (June 12). The results obtained by this machine will be published later.—Charles **Depéret**: An attempt at the general chronological co-ordination of the quaternary period.—A. **Rateau**: The pressure and specific gravity of air in a normal atmosphere.—M. **Riquier**: The elimination of arbitrary constants.—G. **Friedel** and L. **Royer**: The liquids of Grandjean with equidistant planes.—M. Charles Gravier was elected a member of the section of anatomy and zoology in the place of the late M. Ranvier.—M. **Gosse**: Partial differential equations of the second order integrable by the method of Darboux.—Bertrand **Gambier**: Applicable surfaces with equality of the principal radii of curvature.—L. **Dunoyer** and P. **Toulon**: The polarity of the electric arc.—B. **Szilard**: A new electrometer with rigid pointer designed for the measurement of radiations. A description and diagram of the instrument are given: the advantages claimed are transportability, easy adjustment to the zero of the scale, and sensibility. A visible displacement is obtained with 0·01 gram black uranium oxide free from uranium-X.—F. **Guéry**: A curious property of a special mounting of electrical machines excited in series.—Edouard **Belin**: The transmission of handwriting and drawings by wireless telegraphy. An account of additional experiments by the method described in an earlier communication. A reproduction is given of a radio-telephotogram sent across the Atlantic.—Pierre **Jolibois** and Robert **Bossuet**: The precipitation of uranyl nitrate by soda. The radioactivity of the precipitate. The first precipitate formed carries with it a considerable proportion of uranium-X. The oxide of uranium-X is less basic than uranium oxide.—Max **Geloso**: The absorption of iron by precipitates of manganese dioxide.—Ch. **Dufraisse** and P. **Gérald**: The action of alcohols on α-bromobenzalacetophenone.—Henri **Longchambon**: Study of the tritoluminescence spectrum of saccharose. Previous work on this subject has led to the conclusion that the light given out when crystals of sugar are crushed is continuous. It has now been proved that the spectrum is discontinuous, and the bands observed correspond with the second positive band spectrum of nitrogen. The effect is probably due to a silent electrical discharge between two solid particles of sugar suddenly separated and charged electrically. This view is confirmed by the fact that when sugar is broken in a vessel containing air under reduced pressure (40 mm. to 1 mm. of mercury) the luminosity is much more intense.—St. **Jonesco**: The distribution of the anthocyanidines in the coloured organs of plants.—E. **Wollman** and M. **Vagliano**: The influence of avitaminosis on lactation. A rat fed with food deprived of vitamins is incapable of supplying its young with the vitamins necessary for growth. Young rats, from the earliest days of their existence, can utilise vitamins of foreign origin (from yeast and butter).—G. **Mouriquand** and P. **Michel**: Auto-immunisation against deficiency diet.—L. **Panisset** and J. **Verge**: The "donneurs de sang" (horses providing blood for transfusion) in veterinary medicine. The transfusion of blood from one individual to another of the same species is known, in the case of man, to be attended with certain risks (agglutination, hæmolysis). Laboratory experiments *in vitro* and also clinical practice show that these risks are very small with horses or with cattle.—Jean **Delphy**: *Gregarina Sœnuridis* and its host.—W. R. **Thompson**: The study of some simple cases of cyclic parasitism in entomophagous insects.—C. **Levaditi** and S. **Nicolau**: Vaccine and neoplasms.

Official Publications Received.

The National Physical Laboratory. Report for the Year 1921. Pp. 207. (London: H.M. Stationery Office.) 6*s*. 6*d*. net.

The North of Scotland College of Agriculture. Guide to Experiments at Craibstone, 1922. Pp. 42. (Aberdeen.)

Report of the Director of the Royal Observatory, Hongkong, for the Year 1921. Pp. 17. (Hongkong.)

Canada. Department of Mines: Geological Survey. Summary Report, 1921. Part C: Geology and Mineral Resources of Rice Lake and Oiseau River Areas, Manitoba. By H. C. Cooke. Pp. 36C. (Ottawa.)

Canada. Department of Mines: Geological Survey. Bulletin No. 34, Geological Series, No. 41: Physiography and Glacial Geology of Gaspe Peninsula, Quebec. By A. P. Coleman. Pp. 52. (Ottawa.)

Canada. Department of Mines: Victoria Memorial Museum. Bulletin No. 36, Biological Series, No. 8: Land Snails from the Canadian Rockies. By S. Stillman Berry. Pp. 19. Memoir 126, No. 4 Biological Series: A Botanical Exploration of the North Shore of the Gulf of St. Lawrence, including an Annotated List of the Species of Vascular Plants. By Harold St. John. Pp. iii+130. (Ottawa.)

Redogörelse för Skogsförsöksanstaltens Verksamhet under Fyraårsperioden 1918–1921 jämte Förslag till Arbetsprogram: Summary of the Programe of the Swedish State Institute of Experimental Forestry for the period 1922–1926. (Meddelanden från Statens Skogsförsöksanstalt, Hälfte 19, N:r 1.) Pp. 123. (Stockholm: Centraltryckeriet.)

The Journal of the Institute of Metals. Edited by G. Shaw Scott. Vol. 27. Pp. viii+621+35 plates. (London: The Institute of Metals.) 31*s*. 6*d*. net.

Annual Report of the Board of Regents of the Smithsonian Institution showing the Operations, Expenditures, and Condition of the Institution for the Year ending June 30, 1920. (Publication 2622.) Pp. 704+plates. (Washington: Government Printing Office.)

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1921. Pp. 160. (Bristol: The University.)