SATURDAY, OCTOBER 9, 1926.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Geography and Town Planning.

TWO papers presented to Section E (Geography) at the recent Oxford meeting of the British Association—one on Manchester, the other on London—formed the introduction to an important discussion on "Regional Work in Geography." The Town Planning Act, 1919, made possible the reshaping of existing towns and the determination of the lines of future growth. Thirty-seven joint committees have now been formed, including altogether more than five hundred authorities and covering an area of some six million acres. The regions affected differ considerably in area. The Manchester and district region has an area of more than one thousand square miles, and includes about a hundred local authorities; Worthing and district consists of three councils and about fifteen thousand acres. The object of these committees is to lay down in general the lines of road development, housing schemes, and localisation of industries. These somewhat procrustean methods of shaping the geographical future of our towns and countryside are advocated on two main grounds. Some urge the increased industrial efficiency of the region, in which case, road building and the settlement of industrial sites are paramount. Others give precedence to the preservation of historical associations and of scenic beauty, as illustrated by Prof. Abercrombie's work on the future development of east Kent.

That the haphazard growth of our centres of population should no longer continue is eminently desirable; that pushful industry should no longer, like a flood, swallow up all other regional functions is equally desirable. But who is sufficient for these tasks of regional reorganisation? In the light of present developments, should we now approve or disapprove of the purchase of Trafford Park, Manchester, as a public recreation ground? Once the new coal pits of the Sherwood district are raising their maximum output, are we able and do we desire to overcome the enormous attraction the new coalfield will exert on innumerable industries with their regional associations? Few administrative authorities wish to strangle the goose that lays the golden egg.

One danger of this rapid development of regional planning is the lack of knowledge of how the present adjustment has come to be. No doubt economic or administrative pressure can be sufficiently exerted to compel a certain town plan, but if undue pressure is exerted on what would be its normal growth, there will be a tendency towards restricted growth, possibly deformity and decline. To predict the lines of future urban development is asking much of the prophetic powers of man. His only guide is a clear understanding of the growth of places which offer parallels to his own.

This study has been strangely neglected, and the geography of a place has too often been confounded with its economics or the history of its people. Mr. Fitzgerald showed that we are not yet in a position to assess the physical factors continuously emphasising the nodality of Manchester-Salford, and the civic factors which make for the urban independence of the surrounding textile towns. Yet this assessment must be made before the question of federation can be reasonably approached. Economically there would appear to be every reason for the amalgamation of Manchester and Salford. Actually, the citizens of the twin cities are separated by more than the width of the Irwell. Trafford Park, with more than a hundred different industrial undertakings and more than twenty-five thousand work-people, is such an integral part of the Manchester-Salford industrial centre that it would seem an anomaly for it to remain within the two areas of the urban district of Stretford and the rural division of Davyhulme. But what should be the boundary determinants of a single municipal authority, and what weight should be given in particular to historical precedents, to economic necessity and to physical conformity and advantage?

The latter, or site factor, makes the primary appeal to the student of geography. Liverpool has not been able to hold the cotton textile industry at the port. In spite of the serious handicap of haulage of raw material eastwards and manufactured goods westwards across thirty miles of difficult country, cotton has been attracted to the upper Mersey basin within the Pennine and Rossendale gritstone moors. But while Liverpool has failed to accomplish this economic enterprise, Manchester has improved on the handiwork of Nature by converting the unnavigable Mersey-Irwell river into a navigable ship canal. It is this estimate of the extent of man's control over the site of his economic activities which makes town planning for future generations so difficult.

Mrs. Ormsby in her paper on London pointed out the practical difficulties in the acquisition of data upon which town planning must be made. The larger and more complex the area, the greater is the need for some kind of 'plan.' But it is precisely in these cases where extensive co-operation and collaboration is required. In London, for example, the geography—both pure and historical—of each small area needs intensive study before a correct view of the whole can be made. A prerequisite is therefore the development of a technique which will enable the results of workers in different centres to be correctly and fully co-ordinated, and also will ensure in the maximum degree similar lines of investigation and the elimination of the personal equation. Mrs. Ormsby defined the first step in the geographical survey as the production of a base map (scale six inches to a mile) to show so far as possible the general physiographical conditions underlying present distributions. This map should show ground forms by selected contour lines of reasonably close interval and surface deposits, especially such as gravels and clays. The plotting of population distribution at various periods is equally important and much more difficult. It is to be hoped that the research committee of the British Association at present investigating the method of construction and reproduction of a provisional population map of the British Isles will be able in the near future to consider the best methods of plotting urban populations.

The similar plottings of houses of different character, of factories and industries in conjunction with the site and population, indicate the lines of historical adjustment. It is essential that these lines, however much they may be deflected, shall be continued unbroken in all schemes of town planning of existing and old-established human settlements.

Anti-Fundamentalism.

The Ascent of Man by Means of Natural Selection. By Alfred Machin. Pp. xx + 325. (London: Longmans, Green and Co., 1925.) 7*s.* 6*d.* net.

MOST European students are inclined not to take Fundamentalism very seriously; but its power and expansion in the United States are truly alarming. Nor is there any certitude that it will not jump the Atlantic. As a symptom, moreover, it is disquieting. It shows how frail is the hold which science has on modern civilisation; how easily its scope can be mistaken; how strong is the antagonism against the cold light of research, when it dispels man's claims to be the aim of creation. Fundamentalism is certainly not only the most ludicrous but also among the most depressing phenomena of recent intellectual life.

It is well, however, to realise that we cannot blame only the 'crude mystic' and 'uncouth Methodist or Baptist' for Fundamentalism—the Rationalist, as he likes to call himself, is quite as much at fault. There is a tendency among the left wing of scientists to puff up any general principle of science into a metaphysical truth; to build a regular mythology around it; to coin it into dogmas and to make it drag a heavy load of moral responsibilities. Monism, energetics, relativity, the fourth dimension have all been paths from science into dogmatics, and recently we have seen even a new decalogue built upon a crude misapprehension of biological and eugenic ideas. Evolution has been mishandled more frequently than any other principle at the hands of a Hegel and a Comte, of a Herbert Spencer and an Ernst Haeckel. The present book is yet another attempt to play into the hands of fundamentalists by making evolution a rival and an enemy of other metaphysical and religious systems.

The writer takes as his motto the fine phrase by Sir Arthur Quiller-Couch: "The *Origin of Species*—the biggest book of this century, and a new Gospel for the next to think out." Mr. Machin seems to take the expression 'new Gospel' too literally. "The Teaching of Evolution *v.* the Teaching of Religion" is the heading of one of the concluding chapters. In this the author seriously discusses whether Christianity could not be, and should not be, replaced by Darwinism. This latter is naturally made to win the contest, though in an essentially pacific manner. "In the midst of all these contending factions, evolution in the light of natural selection puts forward an olive branch, offers a solution of their various problems, and an explanation of their numerous difficulties" (p. 298). The rôle of a peacemaker is notoriously invidious, and it is to be feared that the solution will not be accepted graciously by the belligerent brands of Christianity and of other creeds. The peacemaker puts himself in a still more precarious position by drawing up a list of "charges which evolution makes against Christianity."

When, however, the charges are laid down, it is not only the orthodox Christian but also the man of science who feels taken aback. For "the practical impeachment [against religion] is this: . . . religion does not teach patriotism as the first of all the virtues; it does not teach the fundamental necessity of economic laws; it does not recognise that patriotism, diligence, and self-denial are the primary virtues, from which alone the sentiments of morality and brotherly love can spring. As a minor charge it will be asserted that there is no true place in Christian philosophy for the recognition of the imperative need for recreation, for physical sports" (p. 298).

'Patriotism' is a word which covers a multitude of sins. Mr. Machin, however, leaves us in no doubt as to his real meaning. His is a patriotism which would be dear to the militarist or even war-time propagandist. We are told that "all developments in the arts of civil life are governed by the arbitrament of war" (p. 175); and, again, that "in the struggle between the different societies it is war—the arbitrament of the sword—that decides the issue" (p. 216). "The first and most obvious fact is that providence is on the side of the big battalions" (p. 216). "Clearly there has been a constant struggle for existence between different tribes" (p. 174). This sort of apotheosis of militaristic ideas would be distasteful to most students, especially as it is presented as the main ethical claim of science as against religion. Science is not specially concerned with the preaching of any type of morality, and the recent ethics of militarism have not brought them nearer to our heart. But the real question for the student is as to the truth and validity of the above assertions. The historian, the anthropologist and the sociologist are bound to deny them categorically. When we are assured that "War between human societies corresponds largely to the struggle for existence in nature" (p. 171), the author commits a mistake made already by early Darwinian enthusiasts and long since repudiated by Kropotkin in "Mutual Aid," Novicow in his "Critique du darwinisme social," and many others.

Mr. Machin adds to this another fact: "The arbitrament of war, it has been remarked, is decisive. Societies that are destroyed by other societies are eliminated from the history of the human race" (p. 173). In this the inaccuracy of his generalisation is blatant. Could there be quoted the case of a single society that has been *exterminated* by war? Even white man has to use subtler and more complicated poisons to deal with his brown coloured brethren before he destroys them completely. In fact, we are dealing here with some of the most difficult and fully discussed questions of anthropology and the science of history. The author seems to be unacquainted with the vast literature of the subject. He advances off-hand solutions of questions upon which volumes have been written, and is thus unable to contribute anything to the advancement of our knowledge. His use of terms is often loose, his logic not above criticism, and his acquaintance with facts very indirect. It is remarkable that in a previous chapter he himself criticises the application of the 'struggle for existence' to human history. He inveighs against Treitschke, Nietzsche, and Bernhardi—the classical trio of British war-time propaganda—only to repeat their mistakes in the crudest manner in the later part of his book.

Another discovery which evolution "as religion" has allowed the author to make is "the importance of wealth." "Evolution is thus primarily not an account of the growth of brain power, of 'goodness,' of social subordination, of increasing differentiation, or the development of super humanity, but of these only as they may have contributed to the improvement of man's estate, to his increasing understanding and control over his environment—to his growing prosperity" (p. 218). This sounds like an exaggerated statement of historical materialism pure and simple. Here again we have a restatement of a point of view so much repeated and debated that it has grown stale for the sociologist. Yet the author, judging from his quotations, is unaware of the existence of Marx, Loria, H. Cunow, and of such of their opponents as Benedetto Croce, Schmoller, and others.

Against the charges of social Darwinism and extreme Marxism the author might shelter himself behind a number of chapters in which he extols altruism and righteousness, parental love and filial piety, the obedience to law and general good temper. Mr. Machin does not even forget the amenities of life, sports and amusements, music-halls and moving pictures, which all form the virtues of the evolutionary metaphysician. Only to religion does he remain decidedly unfriendly and unfair. "The office of civil government, and more particularly of religion, is then essentially negative. . . . Progress, the advancement of individual and national prosperity is not due to religion" (p. 246). Many similar unfriendly sentiments might be adduced from Mr. Machin's chapter on law and religion.

These many virtues and ethical commandments of evolutionism—such as military truculence, Rotarian graspingness, parental love, righteousness, and love of amusement—are, however, not welded into any consistent scheme. At best it is made plausible that they are not inconsistent with the loosely conceived Darwinism. This might be considered satisfactory if we agreed with the author to regard Darwinism as a form of religion. Regarded as a mere scientific method or system of thought, Darwinism, or the theory of natural selection, cannot yield such a multitude of virtues.

Here we come to the really important question concerning the book. Apart from its metaphysical claims—with which it is quite impossible to come to any understanding—the book has a serious and methodologically interesting aim. One of its purposes is to apply the principle of natural selection to the development of culture and to illuminate several aspects of human civilisation in this manner.

To the average sociologist the promise of applying Darwinism to the study of culture sounds as would to the physicist another device for circumventing the first law of thermodynamics by a new plan for establishing perpetual motion. Natural selection, in the sense in which it is used by biologists, does not act on individuals of the human species, because culture stands between man and the selective action of Nature. In the very process of procreation man shows a radical difference as compared with the animal, in that he can and does control fertility and is able to protect the offspring beyond any limits which animals can reach. Mr. Machin, in fact, has seen this point and treated it more fully and intelligently in several of his chapters than most sociologists and anthropologists have done. Beyond parental care, 'mutual aid' is, as Kropotkin has shown, the rule in humanity rather than the 'struggle for existence.' The human individual, again, does not merely rely on anatomical endowment—he has the whole of material culture at his disposal. He is not adapted to his environment merely by his physiological processes and instincts—he has developed knowledge, belief, and tradition. In brief, the animal under conditions of Nature, and man under conditions of culture, show different forms of mating, of co-operation, of practical dealing with environment, in short, of adaptation. Cultural process is not identical with natural evolution, and biological principles cannot be directly applied to the study of man. This is the reason why even such brilliant attempts as those of Bagehot, of Gumplowicz, or of Enrico Ferri have not led very far, and anthropology from Bastian and Tylor up to Frazer and Westermarck has not attempted to apply natural selection to the comparative study of human society. There is, in fact, a considerable methodological literature on the subject of the delimitation between natural and cultural science—to mention only such names as Dilthey, Paul Barth, H. Rickert—and the new attack of the so-called historical school against anthropological evolutionism has justifiably pointed out the dangers of borrowing a method, a terminology, and a conceptual apparatus by one science from another.

Of all this Mr. Machin is apparently unaware. His anthropological quotations do not reach very far beyond Herbert Spencer, who is decidedly not sufficient as a source book and intellectual arsenal of anthropology and sociology. Of this it is impossible to make a valid charge against the present book, for Mr. Machin frankly calls himself a layman in the preface and admits that "this essay is based, in the main, on the works of the two giants of evolution theory—Darwin and Spencer." Nor is it possible to contradict him on this point, for the present book contains no original research, no addition to method, and no really new principles. Perhaps the one exception to this is the discussion of the difference between the regulation of animal and human fertility in the second section of the book. This discussion, however, has no direct bearing on the main anthropological part of his contribution.

There is one aspect, however, under which this book is of considerable importance in spite of its serious shortcomings; and that is the reason why it has been necessary to criticise it more fully instead of damning it with faint praise. Although any attempt to apply the principle of natural selection to the evolution of human culture must, in the opinion of the reviewer, prove unsuccessful, such an attempt raises once more the capital problem of anthropology. Mr. Machin's book reminds us again that man has evolved from lower animal species and that this cannot be denied by any one except the crazy fundamentalist. Human culture again, has evolved from the state of Nature, from a zero level, so to speak. Both these facts bring up the problem: What is the action of natural conditions upon man? What is the difference between human relations to the environment and animal adjustment, what is the difference, in short, between evolution in biology and evolution in culture? The anthropologist of to-day is satisfied with pointing out, negatively, that the cultural process differs from the biological one. This is sufficient reason not to mix them up, but it is not a sufficient reason not to compare them. Only comparison can bring out the essential similarities as well as the differences in either process. Most modern anthropologists of the so-called historical school have been busy pooh-poohing the concept of human evolution and the study of the origins of institutions and the causes of progress.

All these questions are constantly raised by the argument of the book reviewed. Some of the arguments may have to be rejected, but they will have to be replaced, for Mr. Machin has the great gift of seeing the problem and formulating it clearly—a gift of more value in science than the facility to solve irrelevant and imaginary questions. The author is handicapped by his out-of-date reading, by his adhesion to his authorities, and by a lack of first-hand acquaintance with his material. But in honesty of thought, lucidity of exposition, and clarity of style the book is often excellent, and through these virtues it is especially fitted to suggest the real problems to the anthropologist. It is a work which no student of man should omit to read. Science does not thrive by mere avoidance of errors, but by resolute grappling with real problems. From this point of view Mr. Machin's book is a more valuable contribution to anthropology than many modern works which startle us with revelations about the 'diffusion' of culture from Egypt, Atlantis, Yucatan, or some other Garden of Eden. Anthropology will become a useful science only after it has realised once more that the problems of evolution of culture cannot be shirked any more than the problems of evolution of species. If Mr. Machin's book helps in combating anthropological fundamentalism—the bitter opposition to evolutionary thought within the science of man—it will have fulfilled its mission, even though we must reject it as the "new Gospel."

B. MALINOWSKI.

Aids for the Spectroscopist.

(1) *Tabelle der Hauptlinien der Linienspektra aller Elemente nach Wellenlänge geordnet.* Von Prof. H. Kayser. Pp. vii + 198. (Berlin: Julius Springer, 1926.) 24 gold marks.

(2) *Atlas de spectres d'arc: tableaux d'analyse pour les recherches spectrochimiques.* Par Dr. Jacques Bardet. Pp. 55 + 54 planches. (Paris: Gaston Doin et Cie, 1926.) 240 francs.

ONE of the outstanding features of recent progress in experimental physics is the remarkable development of research in spectroscopy. This is largely due to the efforts of theoretical workers who, although the precise physical meaning of their assumptions cannot always be assigned, have nevertheless achieved amazing success in constructing semi-empirical rules for the analysis of spectra. The generality and extremely suggestive character of these rules have inspired fresh investigations of the spectra of the majority of the elements, with the result, among others, that lists of spectrum lines which were once regarded as complete are being augmented to a surprising extent and at an unprecedented rate.

Such an accumulation of data, provided they be accurate, is an unqualified blessing, but its attainment is not unattended by considerable danger. Rapidity of progress does not always allow the application of the rigid and impartial criticism of every detail of the experiment which alone can ensure freedom from error. If, for example, a group of, say, seven lines is predicted in a spectrum, and the experimenter who has already obtained six of them ultimately finds the seventh, and weakest, on a well-exposed plate, the new line runs some risk of missing the stringent test for impurities which is its due. On the other hand, if an unexpected line, or one of uncertain behaviour, appears in a spectrum, it may be rejected as a possible impurity on the 'safety first' principle (a principle, by the way, which in practice often means 'safety only'), and the existence of an important line thereby lost sight of. We have known of recent examples of these and other sacrifices to the ideal of early publication which, in the long run, delay rather than advance progress.

(1) In order to minimise such dangers as these, Prof. Kayser, to whom spectroscopy already owes so much, has placed the scientific world under yet another debt of gratitude by the preparation of the first of the books before us. The table of 'Hauptlinien' at the end of volume 6 of his monumental 'Handbuch der Spektroscopie" (1913) has long been familiar to every spectroscopist, and in the new volume he has adopted the same general method of presentation as was employed therein. The progress of the last thirteen

years, however, has made some changes of detail necessary. The wave-lengths are now given only in international angstroms, Rowland's scale having become obsolescent. The values recorded are the weighted means of all the observations available, and are given only to such a degree of accuracy as the compiler considers trustworthy. The limits of wave-length included have been extended at both ends of the scale, and the table includes fainter lines than the earlier list, so that the total number of lines (now about 19,000) is almost doubled. In the Schumann region, owing to the fact that, of necessity, only the stronger lines are at present observable, all the recorded lines are included. Another modification of the original table is the indication of the degree of ionisation (where it is known) of the element to which a line belongs. Thus, λ 5889·965 is no longer recorded as Na, but as NaI. About 15 per cent. of the stronger lines can at present be so classified.

It is needless to point out the value of such a book as this, or to comment on the excellent manner of its production. It is obviously indispensable to every experimental spectroscopist.

(2) The atlas of M. Bardet is designed to encourage and facilitate the use of spectrum analysis by chemists. It comprises 48 principal plates and a few supplementary ones intended to illustrate special features of the process. Each plate of the main set shows the prismatic spectrum of iron as seen in the microscope, with an adjacent scale of angstroms. Above this spectrum vertical lines are drawn at the positions occupied by the lines of the various elements (the chemical symbol, approximate wave-length and intensity being placed against each line for identification), and it is intended that the experimenter, having photographed the spectrum of the material to be examined in contact with that of iron, shall compare his negative with the atlas and so identify the unknown lines. The 48 plates are divided into six series, in each of which the iron spectrum over the range λ 3500-λ 2500 is shown in 8 plates. In the first series the adjacent lines include all the lines of the elements with fairly simple spectra, and the most characteristic lines of the remaining elements, as they appear in the spectrum of the arc. The remaining series show, in greater completeness, the positions of the lines of the more complicated spectra, each series being devoted to a particular group of elements. In this way overcrowding of lines is satisfactorily avoided.

The iron spectra, though originally drawn by hand, are faithfully copied, and simulate the appearance of photographs remarkably well. The wave-lengths are taken from the tables of Exner and Haschek, and are given in terms of Rowland's scale. The method of using the atlas (in which full use is made of the *raies ultimes* of de Gramont), together with instructions relating to the whole process of spectrum analysis, is given in detail in an accompanying brochure, which contains also a preface by M. Urbain in which the neglect of spectrum analysis by chemists is discussed and deplored.

Both in design and in execution the work is excellent, and the accompanying notes testify to the wide experience of the author in this branch of study. The production should prove of great value not only to chemists but also to all who have occasion to use spectrum analysis. The author is to be congratulated on meeting an obvious need so effectively, and it may be confidently predicted that his work will be widely used. When, however, M. Urbain, in the preface, claims that M. Bardet " est probablement le seul homme au monde qui, d'un rapide coup d'œil jeté sur un spectre, puisse énumérer immédiatement les principaux corps qui l'ont produit," he is presumably thinking only of chemists. There are spectroscopists of much longer experience than M. Bardet who acquired this faculty many years ago.

H. D.

Rubber: Natural or Synthetic?

Synthetic Rubber. By Dr. S. P. Schotz. Pp. 144. (London: Ernest Benn, Ltd., 1926.) 21*s*. net.

THE meaning of the title of this book, although sufficiently clear to satisfy the general public, is, from a scientific point of view, entirely unsatisfactory. The author evidently feels this when in the first few lines he writes:

" Even samples of natural rubber probably differ widely in details of constitution. To attempt to reproduce a synthetic rubber of exactly the same constitution as a specific natural rubber would be difficult and futile. Fortunately it is possible by synthetic means to obtain substances which are constituted similarly to natural caoutchouc as far as the linking of the various hydrocarbon groupings is concerned, having similar physical properties and offering the same resistance to chemical reagents and mechanical influences. The whole development of this coming industry is tending in that direction."

It is therefore clear that the word ' rubber ' is applied to a number of substances or, rather, mixtures of substances which possess certain physical properties in common which are more or less standardised.

Natural vegetable products are rarely found in a chemically pure state: if the substance is a solid of relatively low molecular weight, it is usually capable of being obtained in a state of purity by some method of crystallisation. If the vegetable product is a liquid, it can frequently, but not always, be purified by fractional distillation either under ordinary conditions or under reduced pressure. When the substance is a colloid of high and unknown molecular weight, the above-mentioned methods of purification are not available. It is true that, in the case of most natural caoutchoucs, the greater part, if not all, of the comparatively small amount of 'impurities' it contains can be removed by selective solvents, leaving a residue of presumably pure matter which on analysis gives figures corresponding to the general formula $(C_5H_8)_n$. On subjecting this matter, or the unpurified caoutchouc, to destructive distillation, various hydrocarbons are produced mostly possessing the same percentage composition, but of lower molecular weights than the original substance, and amongst them the key substance to the synthesis of caoutchouc is found. This is the simple hydrocarbon, isoprene, C_5H_8, boiling at about 33°-34° C.

Isoprene was first obtained by Himly in the year 1835 by the destructive distillation of rubber, and was later examined by a number of chemists, but its structure was first determined by Sir William Tilden as being *β*-methyl butadiene :

$$\begin{array}{c} CH_2 = C - C = CH_2 \\ \quad\; | \quad\;\; | \\ \quad CH_3 \; H \end{array}$$

Tilden obtained isoprene by the destructive distillation of both caoutchouc and turpentine, and satisfied himself that the light hydrocarbons obtained from both sources were identical. He further found that, on keeping for a short time, the very mobile isoprene became viscid and, after a period of some years, produced a white solid which had most of the properties of india-rubber. He also examined the catalytic action of a large number of substances on isoprene and came to the conclusion that isoprene was the parent substance of caoutchouc. Other chemists afterwards worked upon the production of isoprene, but almost entirely from a scientific point of view, and the possibility of a commercial synthesis of rubber was not seriously considered until about 1910, when the shortage of rubber and its rise in price to about 10*s.* per pound caused a large amount of work to be undertaken to see whether rubber could be produced commercially.

The problem was attacked seriously both in Great Britain and in Germany. Messrs. Strange and Graham organised a group of research workers in the former, and in the latter the like work was undertaken by the Farbenfabriken vorm. F. Beyer and, to a lesser extent, by the Badische Anilin- u. Soda-Fabrik.

At first the work in both countries consisted chiefly in exploring any possible routes by which isoprene could be produced cheaply. The most obvious method, namely, the cracking of turpentine, was soon abandoned, as the yield of isoprene was too small to be remunerative. Of organic compounds containing 5 atoms of carbon, the most promising seemed to be normal pentane, isopentane, and isoamyl alcohol, occurring in fusel oil.

Normal pentane itself is not, theoretically, a good starting-point, as it contains a straight chain of 5 carbon atoms and, unless isomerisation took place during the series of reactions, only an isomer of isoprene could be obtained. The isopentane route was also explored, but was not persevered with owing to the difficulty of obtaining the raw material in sufficient quantity at that time. Isoamyl alcohol was found to be a good raw material, but it could not be obtained either in sufficient amount or at a suitable price.

The English workers then attempted to get increased quantities of isoamyl alcohol by a fermentation process and, with the help of Prof. Fernbach of the Pasteur Institute, a bacterium was isolated which, acting upon starchy material, produced not isoamyl alcohol but normal butyl alcohol and acetone in a yield of nearly 50 per cent. of the starch taken. Meanwhile the German chemists seem to have reached more or less the same conclusion as their English rivals.

It was known by this time that hydrocarbons possessing the conjugated double linking

$$\begin{array}{c} >C = C - C = C< \\ \;\; | \quad\; | \end{array}$$

were capable of being polymerised into rubber-like substances. As substances of this type containing 5 carbon atoms were not easily obtainable, the German work concentrated upon members of this group containing 4 and 6 atoms of carbon. The 4-carbon substance, C_4H_6, known as butadiene, divinyl, or erythrene, was obtainable in various ways, but no completely satisfactory raw material was obtainable and the Fernbach bacillus was not available to them. They therefore concentrated chiefly upon the 6-carbon member *β*-*γ*-dimethyl butadiene or di-isopropenyl. This substance could be obtained fairly readily from acetone, which was reduced to pinacone, from which di-isopropenyl was obtained without difficulty.

The English group, now having plentiful supplies of *n*-butyl alcohol, worked almost exclusively upon the best method of converting this substance into butadiene, which was by now known to polymerise into a substance having similar properties to the polymer produced from isoprene. The raw materials and methods of producing the hydrocarbons C_4H_6 and C_6H_{10} having been provisionally settled, work now concentrated upon methods of polymerising these into rubber-like substances. Here both groups, almost simultaneously, hit upon the same method, namely, by means of metallic sodium, but the English group, owing to a priority of a few days in the date of the patent specification, succeeded in upholding their patent rights both in Great Britain and in Germany.

It appeared afterwards from the work of Harries on the ozonides of rubbers that so-called sodium rubbers were not identical with the rubbers obtained by simple heat polymerisation. They had, however, remarkably good properties as regards elasticity, etc., and Harries in a paper in the *Annalen* looked upon sodium butadiene rubber as being the best synthetic rubber produced. These rubbers were capable of being vulcanised like natural rubber, which improved their properties considerably, but the 6-carbon rubber, although made on a considerable scale in Germany during the War, did not possess the elasticity of its lower C_4 homologue and was very prone to undergo destruction by oxidation in air. On the other hand, a sample of sodium butadiene rubber recently examined after keeping for a period of thirteen to fourteen years was found to possess its original properties practically unimpaired.

The important question arises : Will synthetic rubber ever supplant the natural substance ? This in the opinion of the writer of the present article is entirely a matter of price. Rubber can be produced on well-managed estates at about 8*d*. per pound. At the present artificial price of 1*s*. 8*d*. per pound synthetic rubber is bound to come shortly, and the probable source will be American petroleum.

Reverting to Dr. Schotz's book : it gives a clear and not too technical account of the art of making synthetic rubber as known to-day. It is fairly free from mistakes, but some have been noticed. On p. 58 bauxite is classed as a hydrated iron compound. On p. 64 1 : 3 dimethyl butadiene should be 2 : 3. The book is somewhat marred by the introduction of plates, dealing with machinery for rubber manufacture, which have no connexion with the subject matter. On the whole, a very readable and interesting account is given of a very technical subject.

Our Bookshelf

British Museum (Natural History). Catalogue of the Machæridia (Turrilepas and its Allies) in the Department of Geology. By T. H. Withers. Pp. xv+99+8 plates. (London: British Museum (Natural History), 1926.) 7*s*. 6*d*.

On account of their sabre- or blade-shaped form, the name Machæridia is proposed for the group of Palæozoic fossils which comprises the genera Lepidocoleus, Turrilepas, Deltacoleus, and Plumulites. These genera are undoubtedly related to one another, but their systematic position has long been a matter of dispute. Although regarded by some authors as Mollusca (Polyplacophora), Cystidea, Annelida, or Trilobita, they have usually been referred to the Cirripedia ; and several writers have looked on them as the ancestors of the stalked barnacles of later times. This view, which is based largely on a comparison with the Chalk form Stramentum (Loricula), is shown by Withers to be untenable, since that genus is now known to be an aberrant type representing a specialised side-line of development from the scalpelliform barnacles, and further, none of the Palæozoic genera can be proved to be Cirripedia, the earliest undoubted representative of that group being found in the Rhætic beds.

In the Machæridia the shell apparently covered the whole of the soft parts of the animal ; it consists of either two or four columns of plates and could open along the whole of the sharp edge, and the plates along the thick margin show muscle-scars indicating the presence of a series of transverse muscles. The fact that the plates in some genera consist of crystalline calcite and show a reticulate structure suggests relationship with the Echinoderma, while the imbrication of the plates and the character of their ornamentation may indicate a connexion with the Cystidea. In his preface to the volume, Dr. F. A. Bather shows that he is inclined to accept this view of the affinities of the Machæridia, and suggests that the Heterostelea and Machæridia are among the earliest offshoots of the echinoderm stem and differ from all other classes of echinoderms in not having had pentamerism and the other echinoderm features impressed on them during an ancestral period of fixation.

Although bearing the modest title of " Catalogue," this work is really of the nature of a monograph and deals in a thorough manner with all the species known. The eight plates are excellently reproduced in collotype from photographs by H. G. Herring.

The Wonder and the Glory of the Stars. By Dr. George Forbes. Pp. 221 + 16 plates. (London: Ernest Benn, Ltd., 1926.) 8*s*. 6*d*. net.

We have much enjoyed reading Prof. Forbes's book, which consists largely of a selection of his numerous lectures delivered during the last twenty-two years and of related essays. The title is a true indication of the author's wish to convey something of his own enthusiasm for the wonders of the night sky accessible to all who care to look for them. Prof. Forbes has long been associated with astronomy, and he has watched its widening horizon from the early days of stellar spectroscopy and astronomical photography. A personal touch is conveyed to the reader by occasional reminiscences of men and events, including an account of a night spent by the author in 1871 at the Vatican Observatory with Secchi and his spectroscope, and impressions of meetings of the Royal Astronomical Society in 1926 which enter into the theme of the last chapter entitled " Fairy Tales by Astronomers."

As already indicated, the book lays no claim to being an elementary text-book of astronomy, but comprises a series of self-contained, yet interdependent articles, the popular nature of which is fully indicated by most of the titles—" Surprise Visitors among the

Stars," "Tornadoes in the Sun," "Stars and their Wireless Messages," etc. By this method of treatment, the reader who scans the pages from cover to cover in an evening or two must necessarily encounter some unavoidable repetition of salient facts. On the other hand, a few points of general interest have been omitted. No mention is made, for example, of the *cyclical* change of the shape of the sun's corona. The description of Cepheid variables might well have contained a few sentences concerning their use in the determination of stellar distances. Again, in the chapter on "Greenwich Observatory" a brief reference is due to the instrument which produced the original of Plate VI., as being typical of another branch of routine work carried on for more than fifty years. It may be added that the type is scarcely large enough for a popular work. There are very few misprints, but the index is defective in a few places. The illustrations are a pleasing feature and include several of the most recent astronomical photographs, the reproduction of which is above the average standard for books of this kind.

A Manual of Elementary Zoology. By Dr. L. A. Borradaile. (Oxford Medical Publications.) Fifth edition. Pp. xvi+670+16 plates. (London: Oxford University Press, 1926.) 16*s*. net.

DR. BORRADAILE'S "Manual" is well known to all teachers of zoology, and, to judge from the frequency with which new editions appear, it must also be well appreciated by students. In these circumstances praise is superfluous and interest centres on the changes which the new edition shows. The most important of these are in the accounts of the movement of Amœba and of the relation of individuality to metabolic gradient, while the introductory chapter, the chapter on reproduction and sex, and that on the animal in the world, have been rewritten—and much improved.

A good deal of new matter has crept into the book since its first appearance, with the inevitable result that the medical student meets in it much that does not concern him, while the pure zoologist finds some rather serious omissions and some cases of too extreme condensation. There is no mention, for example, of Helix, Peripatus, or Ciona, and the reviewer's experience of the chapters on evolution and embryology is that they are too compressed to be of great value to the student. No two authors, however, would solve the problem of what to omit in the same way. On the whole, Dr. Borradaile's choice is a wise one; he maintains a balance between morphology and philosophy which makes his book a scholarly treatise, and one that can be unreservedly recommended.

Elements of Photogravure, Photo Printing from Copper Plates: Screen Photogravure simply explained, with full Working Instructions and an Explanatory Chapter on Modern Rotary Gravure Printing. By Colin N. Bennett. (Lockwood's Manuals.) Pp. viii + 129. (London: Crosby Lockwood and Son, 1926.) 5*s*. net.

MR. BENNETT describes in clear and simple language every step of the process of the making of photogravure prints by the screen plate process, leaving the original dust-grain process with little more than a bare mention as out-of-date. He begins with the getting of the necessary apparatus and materials, and estimates the prime cost to one who has the usual photographic necessities at from 10*l*. to 15*l*. This includes a copperplate printing press. The book appears to provide an answer to every question that a photographer, whether amateur or professional, might wish to ask during his first attempts at the process, even as to where the various items may be purchased. In order to render the volume more complete, the final chapter is devoted to the "Elements of Rotary Gravure," and on the last page Mr. Bennett says that he "does not hesitate to name rotary gravure as the best all-round solution of two and three colour photo-printing." Flat plate gravure is not well adapted for the superposition of two or more impressions, because the damping of the paper renders registration difficult on account of its expansion thereby, and because the capacity of the paper to pick up copper plate ink is much diminished after its first pull through the press.

Biology. By O. H. Latter. ("Science for All" Series.) Pp. vii + 197. (London: John Murray, 1926.) 3*s*. 6*d*.

THIS book may be confidently recommended wherever biology is taught as a subject of general education. Mr. Latter's long experience of biological teaching is an assurance that from the wide field of possible topics his choice will be a wise one, and his book is, in fact, a notable success. Its chapters are linked by the principles of the dependence of living things on one another, and their adaptations to their surroundings. Since it is assumed that time will not be available for general practical work, each chapter ends with a suggestion of suitable demonstrations, which need no special equipment beyond a few microscopes. Two features of the book will make it particularly helpful to its readers—its clear diagrams and Mr. Latter's practice of giving the Latin or Greek derivation of all technical words. He thereby removes, as nearly as possible, one of the chief difficulties of a young biologist—that of mastering the terms in which the science is described.

Grundzüge der mathematischen Erdkunde. Von Prof. Dr. Georg Wegemann. (Sammlung Borntraeger, Band 9.) Pp. 184. (Berlin: Gebrüder Borntraeger, 1926.) 6·60 gold marks.

PROF. WEGEMANN'S book is a compendium of astronomical and geodetic knowledge. It is mainly descriptive, with abundant numerical data; formulæ are quoted but not proved. Time measurement, including many systems not prevalent in modern Europe, the form and motions of the earth, astronomical errors of observation, and the nature of the principal perturbations of the moon's motion, are a few of the varied topics treated.

An Introduction to the Calculus. By Clement V. Durell and R. M. Wright. (Cambridge Mathematical Series.) Pp. vii+91+xi. (London: G. Bell and Sons, Ltd., 1926.) 2*s*. 6*d*.

THIS is a reprint, with slight modifications, of the section on calculus in Part 2 of the authors' "Elementary Algebra." The course meets the requirements of the School Certificate Examination conducted by the Oxford and Cambridge Joint Board.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Kerr Effect in Wireless Transmission.

MR. HOLLINGWORTH'S observations (NATURE, Sept. 18, p. 409) on the polarisation of long wireless waves by day and by night are of great interest in connexion with the attempts which have been made to explain the diurnal variation of atmospheric influences on wireless transmission.

According to the original theory of diurnal variation proposed by Dr. Eccles (*Proc. Roy. Soc.*, A, vol. 87, p. 79, 1912), atmospheric deviation of wireless waves is produced during the day by ionic refraction in a somewhat diffuse layer in the middle atmosphere, while at night true reflection of all wave-lengths takes place from the sharp boundary of the Heaviside layer in the upper atmosphere. According to this theory, the difference between the 'reflection coefficients' of the day and night layers is due to the difference in the degree of variation of ionic content of the under boundaries of the layers.

More recently (NATURE, March 7, 1925; *Electrician*, April 3, 1925) a somewhat different theory has been found useful in linking the mass of evidence relating to geophysical influences on wireless transmission which has accumulated during the last few years. According to this view, the increase of signal strength at night, which is noticeable particularly on the shorter waves, is attributed not to an increase in ionic gradient but to a general lifting of the layer after sunset. The reduction in the collisional 'friction' of the electrons in the layer, due to the increased height and lower pressure, makes deviation with reduced absorption possible. In this connexion it seems clear that the difference between reflection and refraction is determined by the ratio of the thickness of the transitional layer to the wave-length, and, since a transitional layer of several kilometres is contemplated both by day and by night, we may generalise roughly and say that long wireless waves are deviated by reflection and short waves by refraction. The gradient of conductivity (which is determined not only by the gradient of ionic content, but also by the gradient of τ, the time between two collisions of an electron with the gas molecules) is sufficiently high to deviate long waves within a wave-length, while the shorter waves are deviated by ionic refraction brought about by a diminution of the refractive index. Experimental evidence is steadily accumulating which shows that in the latter case ionic refraction without absorption is only brought about, as Sir Joseph Larmor first predicted on theoretical grounds, when the frequency of the waves is higher than the frequency of the electron collisions with gas molecules.

In linking up these ideas with the magneto-ionic theory, in which the effect of the earth's magnetic field on the motion of the electrons is taken into account, a Kerr effect was predicted (*Proc. Camb. Phil. Soc.*, vol. 22, Part 5, p. 675, 1925) for long waves when reflected by the ionised layer at night. Mr. Hollingworth's observations on long waves seem to show that such an effect is appreciable. Considered in conjunction with Dr. Smith-Rose and Mr. Barfield's observations with the Adcock system, they also constitute another confirmation of Mr. T. L. Eckersley's theory of the nature of directional errors.

A consideration of the magneto-ionic formulæ for the conductivity and dielectric constant of ionised gas shows that, in cases of reflection, there is a certain critical height in the atmosphere above which the conductivity in the direction of the earth's lines of magnetic force is appreciably different from that in a direction at right angles. This is the height at which the frequency of the electron collisions with gas molecules is equal to the angular frequency with which the electrons normally spiral round the lines of magnetic force. Taking the earth's field as 0·5 gauss, the critical value of τ is found to be equal to 10^{-7}. Estimates of both mean free paths and air pressures at different heights in the atmosphere, as given by different writers, vary somewhat, but from the available data we may, using the above value of τ, put the critical height somewhere about 70 km. to 80 km. When the waves are deviated below this height, practically no abnormal polarisation is produced, but when deviated above, both Kerr and Faraday effects will be produced according to the wave-length. The fact that the Kerr effect is found at night and not by day indicates that the ionised layer passes from or below this critical region to a height appreciably above it at sunset. Current determinations of the height of the layer for these wave-lengths by day and by night support this conclusion.

E. V. APPLETON.

Wheatstone Laboratory,
King's College, London,
September 21.

Early Egypt and the Caucasus.

As the careful summary of the meeting on this subject at Oxford (NATURE, September 25, p. 463) stops short before my reply to the difficulties there raised, I trust that I may be allowed to complete the report. We must consider the reasons for retaining the view of the dependence of the Fayum on the Nile flow, which has been held by engineers, geologists, and historians during the last fifty years—much of history depends on the conclusions.

The essential question is to choose between the received view (*a*) that the Fayum lake gradually rose by the rise of Nile level up to 205 or 220 feet over the present lake, and was suddenly dried up by restricting the inflow, under the Ptolemies; or the new view (*b*) that there was a high lake in the early human period, which was gradually dried down to the present size. The complete drying up would not take more than twenty-five years.

For the view (*a*) there are six reasons. Physically there is (1) an open channel from the Nile, the mud in which is at least as low as the Nile was at 5000 B.C., and it is unlikely that this would become blocked when a large mass of water was flowing to and fro every year. (2) It would be impossible to maintain a lake at high level unless fed by the Nile; the adjacent deep basin of Wady Rayan has not had any historical lake, because there is no Nile inflow. Historically we see (3) there are an early cooking-pot, fire, and flints *in situ* at 170 feet level, while the water in Greek times must have been up to over 200 feet, by a site being called the "crocodile island," so the lake level was rising and not falling. (4) There is no trace of human work anywhere below the Nile level of its own age, which points to the lake covering the ground up to Nile level. (5) There are four structures of stone, all at the same level, which cannot be reasonably explained except as quays of late origin, and these are at 215 feet level, showing the late lake to have been far above the early flint work. (6) Direct evidence is that of Herodotus; he states that the water flowed for half the year out of the lake to the Nile, and he names the different amount of tax on fisheries during the inflow and outflow. These reasons for the old view (*a*) seem to outweigh the interpretation of traces of the lake levels, after 2000 years of denudation which are adduced for the new view (*b*).

The geologists made objections, which were unfortunately irrelevant, as to the relation of Badarian to Solutrean culture; for it would be useless to expect that different branches from one culture, travelling 3000 miles apart under very different conditions, should retain the same details.

Permit me to add a parallel to the view of there having been an Asiatic centre of distribution for the Solutrean, Badarian, and some western neolithic culture. In the thirteenth century there were European settlers in Greenland, who were later exterminated by advancing cold, and savage Eskimos, much as Solutreans were exterminated in Europe. In the seventeenth century the same race settled in Greenland again and in New England. An American archæologist in future might say that no resemblance could be seen between these invasions, the clothing of the first age was different from that of the second, the architecture and arms of the second age were unknown in the first. Yet we know, from fuller detail, that they were of one race and one culture. Differences do not count in such a question; resemblances are the trustworthy facts.

There were five independent subjects noticed at the above meeting, each of which has to be judged on its own evidence, and the settlement of one subject will not prove or disprove any of the others, though they are closely connected in results.

Flinders Petrie.

Variability of Species.

The writers have, on one hand, been examining the variability of thirty-five species of Lepidoptera, chiefly common British moths, and, on the other hand, studying the variation to be expected theoretically in a population exhibiting inheritance wholly on Mendelian lines, with the corresponding appropriate mutation frequencies, under the influence of natural selection. The conclusions at which they have respectively arrived show a sufficiently striking agreement to suggest a theory which may be generally applicable to the natural variability of wild species.

The actual variance exhibited is regarded as having been arrived at as an equilibrium condition between the action of mutations tending to increase variability, and of selections tending to diminish it. If in such an equilibrium the mutation rates, and also the selection rates, were the same for all species, then the variance would be proportional to the population of the species. We know of no reason for supposing that the mutation rates are different for species differing in abundance, but it is *a priori* probable that in abundant species individual survival is less fortuitous, and more selective, than in rare species; while it is easily demonstrable that in species in which a higher proportion of the total variance is ascribable to genetic causes, the effective selection will be more intense than in species in which the variance is to a larger extent ascribable to environmental variations. On these grounds we should expect the more abundant species to be, in fact, the more variable, though to an extent which can only be ascertained by observations.

Charles Darwin ("Origin of Species," Chap. ii.), in studying the causes of variability, attempted a statistical investigation of material relating to a large number of different species of plants. He was, perhaps unfortunately, dissuaded from publishing his actual tabulations, but gained the concurrence of Hooker to the general conclusions that "wide ranging, much diffused, and common species vary most." Darwin was concerned to show that it was not merely that wide ranging forms give rise to local varieties in reaction to different inorganic and organic environments, but also that, "in any limited country, the species which are most common, that is, abound most in individuals, and the species which are most widely diffused within their own country (and this is a different consideration from wide range, and to a certain extent from commonness), oftenest give rise to varieties sufficiently well marked to have been recorded in botanical works."

The accompanying observations concern not "well marked varieties," but individual variation in a continuously variable character, namely, depth of pigment of the ground colour of the forewing, the variability found being that exhibited in each case in a single locality. As is shown in Fig. 1, the average variance of the abundant species is almost double of that of those species which are comparatively uncommon;

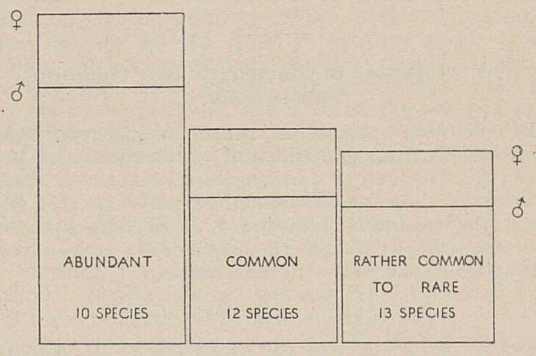

Fig. 1.

the values for males and females are shown by the lower and upper lines, the agreement of which gives some indication of the statistical trustworthiness of the results.

The data thus supply a complete confirmation of the conclusion arrived at on purely theoretical grounds; moreover, the fact that Darwin's observation with respect to "well marked variations" should be equally applicable to continuous variation would be unintelligible if, as is sometimes assumed, continuous variation had some origin distinct from the familiar Mendelian mutations.

Finally, the female moth is distinctly the more variable, the difference being nearly constant at about 38 per cent. for all degrees of abundance; this fact supplies a confirmation of theoretical anticipations of an unlooked-for kind. It has been argued (*e.g.* G. Dahlberg, "Twin Births, etc.," p. 231) that the sex with the greater number of sex chromosomes should therefore show the greater variability; a closer examination shows that this consequence will follow only if the dominant gene is, in the population concerned, generally less numerous than the recessive. (It should be noticed that this does not imply that the dominant genotype is generally the less numerous.) Our previous investigations (Fisher, 1922, *Proc. Roy. Soc. Edin.*, 42, 321) have, however, shown that in any character subject even to small selective influences the recessive gene will nearly always be the rarer. Consequently the heterogametic sex, which is the female in moths, should be the more variable, since a single recessive factor exercises its full effect in an XY chromosome pair, though in all other cases it requires also a recessive partner. Numerically, on the simplest assumptions, we should expect the variability due to the sex chromosome in the heterogametic sex to be increased by about 9·86 per cent., while that of the homogametic sex should be diminished by 27·47 per cent. The difference is 51·5 per cent. of the smaller value, and on comparing this with our observed difference of 38 per cent. it will be seen that either additional causes must be sought for the striking excess of female variation, or the greater part of the variation present must be ascribed to the sex chromosome, which is unlikely.

Whatever may be the explanation of this great apparent activity of the sex chromosome, the two main inferences from the statistical study of the effect of Mendelian factors under selection, (1) that variability in any one locality is greater for the more numerous species, (2) that it is greater in the heterogametic sex, have both been unmistakably verified in the body of material which we have examined.

R. A. FISHER.
Rothamsted Exp. Station.
E. B. FORD.
Wadham College, Oxford.

The Atomicity of Electricity as a Quantum Theory Law.

IN the five-dimensional theory of the connexion between electromagnetism and gravitation first proposed by Th. Kaluza (*Sitzungsberichte d. Berl. Akad.*, 1921, S. 766; see also O. Klein, *Zs. für Phys.*, 37, 875, 1926), the equations of motion of an electrified particle may be shown to be the equations of geodetics belonging to the following line element:

$$d\sigma = \sqrt{(dx^0 + \beta\phi_i dx^i)^2 + g_{ik}dx^i dx^k}, \quad (1)$$

where x^1, x^2, x^3, x^4 are the co-ordinates of ordinary space time with the line element $g_{ik}dx^i dx^k$, while x^0 is a fifth co-ordinate, and the ϕ_i are the four co-variant components of the electromagnetic potential vector. If the constant β is given the value

$$\beta = \sqrt{2\kappa}, \quad (2)$$

κ being the Einstein gravitational constant, the 14 field equations of the Einstein theory may, moreover, be simply expressed by means of the curvature tensor belonging to this line element.

Let now $d\tau$ be the differential of proper time belonging to a particle of mass m and charge e; then the Lagrange function L for the geodetics representing the motion of the particle may be given the form

$$L = \tfrac{1}{2}m\left(\frac{d\sigma}{d\tau}\right)^2. \quad (3)$$

Defining momenta in the ordinary way by putting

$$p_i = \frac{\partial L}{\partial(dx^i/d\tau)} \qquad (i = 0, 1, 2, 3, 4), \quad (4)$$

p_0 is seen to be constant along a geodetic, since x^0 does not appear in L. In addition to the equation expressing this constancy, the system belonging to (3) contains four equations which indeed become identical with the equations of motion of the particle if we put

$$p_0 = \frac{e}{\beta c}. \quad (5)$$

With this choice of p_0 the momenta p_1, p_2, p_3, p_4 are further seen to agree with the ordinary definition of the momenta of an electrified particle.

Now the charge e, so far as our knowledge goes, is always a whole multiple of the electronic charge, so that we may write

$$p_0 = \frac{N\epsilon}{\beta c}, \quad (6)$$

ϵ being the electronic charge and N a whole number, positive or negative. This formula suggests that the atomicity of electricity may be interpreted as a quantum theory law. In fact, if the five-dimensional space is assumed to be closed in the direction of x^0 with a period l, and if we apply the formalism of quantum mechanics to our geodetics, we shall expect p_0 to be governed by the following rule:

$$p_0 = N\frac{h}{l}, \quad (7)$$

N being now a quantum number, which may be positive or negative according to the sense of motion in the direction of the fifth dimension, and h the constant of Planck. Comparing (7) with (6), and making use of the value (2) of β, we get for the period l:

$$l = \frac{hc\sqrt{2\kappa}}{\epsilon} = 0{\cdot}8 \times 10^{-30} \text{ cm.} \quad (8)$$

The small value of this length together with the periodicity in the fifth dimension may perhaps be taken as a support of the theory of Kaluza in the sense that they may explain the non-appearance of the fifth dimension in ordinary experiments as the result of averaging over the fifth dimension.

In a former paper (*Zs. für Phys.*, *l.c.*) the writer has shown that the differential equation underlying the new quantum mechanics of Schrödinger can be derived from a wave equation of a five-dimensional space, in which h does not appear originally, but is introduced in connexion with a periodicity in x^0. Although incomplete, this result, together with the considerations given here, suggests that the origin of Planck's quantum may be sought just in this periodicity in the fifth dimension.

OSKAR KLEIN.
Copenhagen, September 3.

The Rôle of the Cerebellum in the Co-ordination of Animal Movement.

THE intracerebellar nuclei, forming, as they do, important stations on the course of the cerebellar reflex arcs, naturally invite inquiry as to the kind of influence they exert on the muscles. Our observations have been made on the cat, decerebrated in deep anæsthesia according to Sherrington's original technique, the plane of transection of the neuraxis passing just in front of the superior colliculus and in front of the infundibulum, thus leaving intact the *nucleus ruber*. Horizontal slices were then removed from the cerebellum on one or both sides, so as to expose for stimulation the dorsal surfaces of the nuclei. Measures were taken to arrest the bleeding and to maintain the proper temperature. The approximate position of the nucleus in question having been determined by measurements, the section of cerebellum in this neighbourhood was then carefully explored with minimal currents applied by a unipolar electrode. The following is a brief résumé of our results obtained by stimulation of the several nuclei.

Faradisation of the outer side of the *nucleus dentatus*.—This yielded repeated flexions at the elbow of the ipsilateral foreleg, when the limb was already somewhat flexed owing to the cerebellar removal; the limb was also abducted. Results of this kind were obtained by Horsley and Clarke. The contralateral foreleg, previously in slight extension, showed adduction with palmar flexion of paw. The hindlegs already extended became more rigid in extensor tone.

At times the ipsilateral foreleg passed from flexion into extension on stimulation of the dentate nucleus; or if originally extended the effect of stimulation was to diminish the tonus. Similarly the hindlegs sometimes showed an inhibition of their tonic rigidity. The tail has been seen to point opposite to the stimulation, whilst the body was curved with the concavity contralateral.

Faradisation of the *nucleus emboliformis*.—This elicited in the ipsilateral foreleg, when previously slightly flexed, more marked flexion at elbow and paw together with adduction. The contralateral foreleg already rigidly extended showed diminished tonus. The ipsilateral hindleg showed inhibition of extensor tonus, the contralateral hindleg increased extensor tonus. The ipsilateral foreleg when originally extended showed inhibition of tonus. The tail was elevated and rotated rapidly. The eyeballs were rotated on the visual axes, the upper parts turning towards the stimulation.

Faradisation of the *nucleus fastigii*.—Manifestations consisted in strong flexion of both forelegs, already somewhat flexed in consequence of the cerebellar ablation; the toes were spread apart. The ipsilateral hindleg was flexed, the toes being separated.

Obviously, from these results, stimulation of the nuclei may yield either an increase or a diminution of tonus, the outcome apparently depending on the functional state, whether of activity or depression, of the infracerebellar centres. It is known that certain regions of the cerebellar cortex yield on stimulation inhibition of muscular tone, and, since these regions are linked with the internal nuclei, the inhibition elicitable from these latter becomes intelligible; thus support is furnished for a doctrine of cerebellar function recently enunciated by one of us, namely, that control of postural tone by the cerebellum may be either in the direction of augmentation or of inhibition (*Physiol. Rev.*, 6, 124, 1926).

FREDERICK R. MILLER.
N. B. LAUGHTON.

Department of Physiology,
University of Western Ontario,
London, Canada, August 23.

The Action of Silica on Electrolytes.

IN a letter to NATURE (January 2, p. 17, 1926), Dr. Joseph suggests that I have modified my point of view. I am rather more confirmed in it. There are really two points at issue between Dr. Joseph and myself. (1) Dr. Joseph holds the view that our usual conception of ionic equilibrium in heterogeneous systems is sufficient to account for the liberation of acids when hydrated silica reacts with electrolytes (*J.C.S.*, 1923, 123, 2022; 1925, 127, 2813). We consider the reaction to be an example of an equilibrium between ions in the double layer and those in solution. As stated in my previous letters to NATURE, we believe that the surface primarily adsorbs anions. (2) Consequently the adsorption of acid by hydrated silica is also to be expected.

I shall take up the second point first. Dr. Joseph denies the existence of what we call 'primary' adsorption. This adsorption is to be calculated after taking into account the diluting effect of water of hydration (*Phil. Mag.*, vi. 44, 1922, p. 337). From the data given in my letter in NATURE of January 31, 1925, it would appear that the water of hydration cannot account for a diminution in concentration of about 90 per cent. The amount of primary adsorption is small and is found to be of the order of 10^{-4} gram moles of hydrochloric acid per gram mole of silicon dioxide. The failure of Dr. Joseph to confirm our results is to be ascribed to his having used 1 gram of silica and 100 c.c. of solution.

The smallness of the amount of adsorption is not against our point of view, as the adsorption of other anions is likely to be less than that of hydroxyl ions. We have observed that the total amount of acids that can be liberated from these samples of silica by repeated washing with saturated solution of potassium chloride is 6×10^{-4} gram equivalents of acid per gram mole of silica (*Quarterly J. Indian Chem. Soc.*, vol. 2, 1925, 211).

We shall now deal with the first point. In his second paper (*loc. cit.*), Dr. Joseph observes that calcium silicate is more insoluble than the corresponding barium salt. Dr. Joseph also states that solubility relationships explain the observations regarding the interaction between silica and neutral electrolytes. On this basis it is to be expected that under identical conditions calcium should, in contact with silica, liberate hydrogen ions at a higher concentration than barium chloride. On the other hand, from theoretical considerations of the effect of these cations on the electric charge of the surface of hydrated silica, barium should have a greater effect than calcium, and consequently barium should liberate hydrogen ions at a greater concentration. This is what we have observed, and I think the observation cannot be explained from Dr. Joseph's point of view based on considerations of solubility as usually applied to such reactions.

We have also observed that at higher concentrations individual differences between different cations decrease. Here also solubility relationships fail even if we consider the formation of some sort of solid solution. Besides silica there are other systems, *e.g.* manganese oxides, which behave similarly.

J. N. MUKHERJEE.

Physical Chemical Laboratory,
University College of Science,
92 Upper Circular Road, Calcutta.

The British Patent Office.

IT is to be hoped that the arguments in the leading article in NATURE of September 18, for reforms in the patent system which would increase the chance of an issued patent being valid, will have effect.

It is undoubted that the value of a patent would be increased if the British Patent Office were given greater powers by the enlargement of the field of the investigation made as to novelty and by allowing the Patent Office to pronounce on the question of quantum of subject matter. The Patent Office examiners in Germany, for example, have this power, so why not those in England? It is common experience that the investigation as to novelty now made by the Patent Office examiners is, within the limited powers granted to them, more efficiently carried out than in any other country. One difficulty in the way of allowing the Patent Office to give a definite decision on validity is not so great as it appears. It is very doubtful whether 'prior user' alone is often the determining factor in deciding the invalidity of a patent. In most cases the relevant process or article has been described also in a patent specification or in text books or periodicals of the art. It is to be noted that in Holland, where the powers of the Patent Office examiners are great and their attitude towards claims strict, the validity of a patent is guaranteed after five years' freedom from successful attack.

It would help to inspire confidence in the worth of a patent, even under the present system, if the examiners in the Patent Office were to be more strict in their requirements as to the clear and precise definition of an invention and the distinguishing of it from the prior art. At present a patent agent can usually form a correct opinion from reading a specification as to its scope, but the ordinary manufacturer, however 'skilled in the art' he may be, must frequently find himself at a loss. It requires no fresh legislative powers for the Patent Office to require an applicant to state unequivocally what is the monopoly claimed in terms which, whilst appealing rather to a craftsman than a lawyer, would yet be precise enough to satisfy the latter.

This defect is probably due to the attitude of 'leave-it-to-the-Courts' which is a relic of the days before the Act of 1902 came into force, and would tend to disappear if it were established that the greatest possible assurance of the validity of a granted patent were to be striven for, and that only in the very last resort should patent matters come before the Court.

Ernest E. Towler.
Patent Department,
Standard Telephones and Cables, Ltd.

Apocryphal Medical Science.

Our attention has been directed to a book called "Microbe Hunters" recently published by Messrs. Harcourt, Bruce and Company, New York, and alleged to have been written by one Paul de Kruif—a gentleman whose name is quite unknown to us. The work evidently aims at being a kind of popular history or rather romance regarding medical discovery, and mentions us among others. We should like an opportunity to say, for the information of readers of Nature, that the author's statements about ourselves and our researches are almost entirely apocryphal; that they are not supported by reference to the original literature; that they are largely imaginative or spurious; and that his knowledge of the subjects with which we have been concerned is obviously incomplete.

We have been legally advised that some of his assertions regarding ourselves are libellous according to British laws; but in America we have no means of protection except a public denial of the truth of his allegations, and we therefore trust that we may be allowed to publish such a denial, as emphatically as we may, in the columns of Nature.

Dr. Cuthbert Christy's signature does not appear on this letter, as he is in Africa; before sailing, however, he left us the following statement: "With regard to Chapter IX. of Paul de Kruif's book 'Microbe Hunters' I beg to emphatically state that it contains statements which are totally erroneous, misleading and some of them libellous. As an example I will quote paragraph 2, page 264, which reads: 'The third member' (namely, myself) 'became disgusted with the ignorance and failures of his two colleagues and went off prospecting for rubber. . . .' This paragraph is absolutely untrue and libellous. It suffices to say that I have always given credit to Castellani for his discovery of the trypanosome as the etiological agent of Sleeping Sickness—see for instance my letter to the *Morning Post*, August 22, 1923. As regards my abandoning my colleagues and going off prospecting for rubber, this is entirely libellous. I never abandoned my colleagues and, as a matter of fact, I did not get interested in rubber until 1906, which was three years after the labours of the First Sleeping Sickness Commission were completed."

Aldo Castellani.
George C. Low.
David Nabarro.
Ronald Ross.

Kammerer's Alytes.

As I have been both misquoted and misrepresented by Prof. MacBride in a recent letter to Nature (August 21, p. 264), I may be permitted to say a word in my own defence. My remarks on Kammerer's Alytes at the British Association were to the effect that the sections sent by Dr. Kammerer to America showed only asperities, not distinctive glands characteristic of the nuptial pads of other Salientia. The glands in his sections of the controls were the same size as those in his experimentals. Asperities may be formed on different parts of the body in one or both sexes of different species of frogs, and in some cases are apparently not correlated with a sex hormone. In the case of Kammerer's results, the question concerned the inheritance of spines, not of complete pads. Prof. MacBride seems to believe there has been some confusion in my mind on this subject.

In regard to the only specimen in existence of Kammerer's experimentals exhibiting merely a "clumsy attempt at 'faked' restoration," made "after its return to Vienna," we have Kammerer's own word that the blackened areas were present in the specimen when it went to England (Przibram, 1926, Nature, August 7, p. 210), and moreover these areas are the only "nuptial pads" which show up in the photograph made in Cambridge (Kammerer, 1924, "The Inheritance of Acquired Characteristics," New York, Fig. 9) or in the one made in Vienna (Kammerer, 1919, *Arch. f. Entwicklungsmech.* 45. plates x-xi). Further, these blackened areas deceived two able biologists in Vienna who examined the specimen in my presence.

The question of Proteus is, of course, entirely irrelevant. The young Proteus possesses eyes, and the mere fact that certain individuals due to an irregularity of development, whether or not casually connected with an abnormal environment, should have continued the development of these structures, has no bearing on either the question of the inheritance of acquired characters or of Kammerer's experiments with Alytes.

G. K. Noble.
The American Museum
of Natural History,
New York, N.Y.

Variation of Penetrating Radiation on the Jungfrau.

Our new researches on the penetrating radiation in the region of the Jungfrau have now reached a partial conclusion. As is well-known, the existence of this radiation was proved by balloon observations in the years 1909–1914, and, in particular, their extraordinary hardness, which pointed to a cosmic source, was then established by Kolhörster. Afterwards, Nernst in 1921 suggested that their origin lies in recently formed matter. Our researches in 1923–1924 did, in fact, give indications of a sidereal periodicity of intensity of the radiation. These variations can now be closely followed with our more sensitive instruments. It appears that the radiation reaches maximum intensity when certain celestial regions culminate, for example, the Milky Way, and specially the regions of Andromeda and of Hercules. This is explicable as a consequence of the minimum length of the path of rays from these regions through our atmosphere at culmination. The measurements were made at different stations on the Jungfrau up to heights of 14,000 feet, and on the Mönch peak at 13,500 feet above sea-level. Glacier ice was in general used as screening material.

W. Kolhörster.
G. von Salis.
September 14.

Function and Design.[1]

By Prof. J. B. LEATHES, F.R.S.

AMONG natural sciences physiology takes a place which in one respect is different from that taken by any other. It studies the phenomena of life, but more particularly the ways in which these phenomena are related to the maintenance of life. Anatomy and morphology are concerned with the forms of living organisms and their structure; biological chemistry, as distinct from physiology, with the composition of the material in which the phenomena of life are exhibited. The province of physiology, in studying the functions of these forms and of this material, is to ascertain the contributions that they make to the organisation of the living mechanism, and learn how they minister to the maintenance of its life. Function implies ministration; structure for physiology implies adaptation to function, what, in a word, may be termed design.

Ultimate analysis of the phenomena with which physiology deals leads to the fundamental distinction between matter in which life is manifested and matter in which it is not. Life is exhibited only in aqueous systems, containing unstable, perishable combinations of carbon with hydrogen, nitrogen, sulphur, phosphorus and oxygen, in the presence of certain inorganic ions, those which are present in the sea, the native environment originally of all forms of life. The inalienable property that such matter exhibits when alive, and that matter which is not alive does not, is that these unstable organic combinations are for ever reforming themselves out of simpler combinations that do not exhibit this property, and do so at a rate which averages at least not less than that at which they break down. This power of self-reformation, spontaneous regeneration, operates not only when living organisms, cells or communities of cells are growing or reproducing their kind; the very maintenance of living existence requires by definition that it should persist. In the absence of water, the living process may sometimes apparently be suspended for a time, as it may be if the surrounding watery medium is immobilised by cold; it is a question whether this is anything more than a retardation to a rate of change that is imperceptible by the ordinary methods of observation, and a question how long such suspended animation is possible where it is possible at all.

Chemical analogies for this power of spontaneous regeneration, if such exist, can only exist in part; in the present state of our comprehension of it, certainly, it is hazardous to try to trace them. The attempt so commonly made to trace one between the growth of living matter and the growth of crystals in a saturated solution, it is safe to say, is in so many respects on the wrong lines that it is merely misleading.

Let us for a moment consider what this spontaneous regeneration implies. Of the various chemical components of protoplasm, proteins are generally considered the most important, often the only important, ones. The elucidation of the chemical principles upon which the structure of proteins rests, which took place about the beginning of this century, was, like the neurone hypothesis of the structure of the nervous system, an advance the magnitude of which only those, perhaps, can appreciate who began the study of physiology well back in an earlier one. For a time it seemed in each case that the problem was solved and all that was to follow was simple. Those were great days.

The best-known varieties of proteins, when detached and uprooted from the place where they grew, consist of chains of about a hundred, sometimes nearly two hundred, links. Each link is an amino acid coupled by its acid group to the amino group of one neighbour and by its amino group to the acid group of its other neighbour, a molecule of water being lost at each linkage. There are not more than about twenty different amino acids, so that some of them must occur several times in the chain; in some kinds of protein one amino acid may occupy thirty or forty of the hundred places in the chain. In any such isolated protein it is probable that the order as well as the proportion in which each amino acid occurs in the molecule is fixed, and it is this specific order and proportion that accounts for the specific character and properties of the protein. What could be simpler? Only yesterday all was so obscure.

It is not recorded that in the rush of this advance any one stopped to reflect what number of formations such a protein might still possibly have. Supposing it were a chain of only fifty links, a very simple case; if all the links were different, the number of possible permutations is denoted by the innocent-looking symbol $\underline{|50}$. If, instead of all being different, one kind of link recurred ten times, the number would be reduced to $\underline{|50} / \underline{|10}$. If, in addition, there were four that recurred four times and ten that recurred twice, it would be further reduced to

$$\underline{|50} / \underline{|10} \times (\underline{|4})^4 \times (\underline{|2})^{10}.$$

It would now consist of a chain of only fifty links, of which there were only nineteen different kinds, and the number of different arrangements of its parts would be about 10^{48}. Astronomy deals with big figures. Light, it is said, takes 300,000 years to travel from one end of the Milky Way to the other; this distance expressed in Ångström units, 10,000,000 of which go to a millimetre, would be less than 10^{32}. So far are we from knowing the structure of protein molecules! So far are we from knowing what variations in disposition of the parts in such a molecule may not occur without our being within a measurable distance of detecting them! For if the number of possible varieties of a protein the molecular weight of which is known, and known to be exceptionally small, which contains the several amino acids in a known proportion, is so great as this, the number that is possible when that proportion may be changed is practically incalculable, each change in proportion being capable of a number of new arrangements that could be calculated, as was done for our hypothetical case.

Now it is possible that the analogy of crystal formation may be applied to the reproduction of the characteristic order in which the linkings occur, and that the parts out of which a new chain is to be formed may

[1] From the presidential address to Section I (Physiology) of the British Association delivered at Oxford on August 5.

be collected and brought into position alongside of the corresponding parts of an existing chain by forces that are similar to those that determine the latticed relations of atoms in a crystal. But something more than this is required to account for the linking up of these links by the loss of water, and still more for the fashioning of the links themselves. We have to suppose that it is by selective emphasis of certain otherwise unemphasised but possible arrangements of atoms or groups of atoms, evidence for the occurrence of which under similar conditions in the absence of life is generally not obtainable. Specific catalysed syntheses must cooperate with the forces that merely sort out and place in proper order the assembled parts, and must fashion for them the particular links that they need at each step. Specific catalytic agents playing an important part in cell chemistry are familiar in the enzymes found in digestive secretions and also locked away within the cells themselves.

In the chemical make-up of protoplasm, proteins, the most abundant component, are not the only ones that are necessary. Pre-eminent among the others are the nucleic acids. When we consider what has been learnt of the behaviour and of the chemical composition of the nuclear chromosomes, and that according to Steudel's reckoning the nucleic acids form 40 per cent. of the solid components of these chromosomes, into which are packed from the beginning all that pre-ordains, if not our fate and fortunes, at least our bodily characteristics down to the colour of our eyelashes, it becomes a question whether the virtues of nucleic acids may not rival those of amino acid chains in their vital importance. From Steudel's figures it can be reckoned that there are about half a million molecules of nucleic acid in a single sperm cell of the species with which he was working.

In addition to nucleic acids there are also strange compounds of higher fatty acids containing suspiciously significant groups, identical in their general character with those found also in nucleic acid, namely, phosphoric acid, organic bases and sugar; and besides these there are the mysterious sterols. All of these are frankly insoluble in water, and yet have in some part of their composition features that make them not indifferent to water or even to the molecules and ions that exist in true solution, in the liquid state, within the cell. The physical condition of these insoluble substances in the aqueous system of the cell is still little understood. All that can be said with certainty is that they must modify its homogeneity even more than the long floating chains of amino acids, however much these may be linked together one with another. If the characteristic behaviour of living matter is rightly regarded as due to the order that it introduces into the movements and spatial relationships of foreign molecules in its vicinity, then these insoluble components may well be expected to play a leading rôle by forming films and surfaces that permeate its texture and delimit its parts.

If this analysis is approved and the distinctive property of living matter, the power of self-regeneration, depends upon the power of limiting the movements and directing and controlling the spatial relations of surrounding molecules so as to modify their chemical behaviour, it is the exercise of this same power that leads to the formation of substances such as starch, glycogen and fats; and in so far as such substances contribute to the regeneration of the living matter, the power of forming them contributes to its survival. Where energy is necessary for such synthetic rearrangements of adjacent matter, it may be derived from the radiant energy of the sun or from the combination of oxygen with adjacent organic matter.

This faculty of regeneration implies the power of introducing order into the chaotic movements of adjacent matter in conformity with patterns that it possesses. It is a faculty resident in material that is capable of incalculable variation. The number of permutations of its parts that are possible without affecting the results of such analysis as is practicable defies calculation. Some of these permutations confer synthetic powers which others do not. When they appear, are they not what biologists call, for short, mutations? But when they appear, if they retain the power of self-regeneration, and if they minister to its maintenance, they will *ipso facto* survive. For whatever promotes persistence of this power must itself survive.

A disposition of matter in molecules or aggregates, unstable and incalculably variable, that has and retains the power of determining the disposition of matter not yet so disposed, in such a way as to conform to its own disposition or to patterns which help it to exercise this power, is all that must be premised for the whole of evolution to follow. Variations that do not or cease to contribute to the retention of this power do not survive. The condition of survival is ministration to self-regeneration, that is, to the maintenance of life.

Before the days of vertebrates, in pre-Silurian time, an unstable variation occurred in certain types in the disposition of atoms and organic combinations of atoms that was mainly protein in character, a protein to the making of which little short of 200 amino acid links must contribute. Coupled to this protein, which probably is not the same in all species of animals in which it is found, is another group containing iron that is probably always the same. This group is of remarkable nature, and is closely related to one that occurs in the far older substance chlorophyll. This complex substance hæmoglobin had the power of attaching to itself two atoms of oxygen for each atom of iron that it contained in such a way that it could be readily detached and made available for effecting oxidations. Such was the service that this variation rendered that it is safe to say that without it there could be no vertebrate creation. It is this service that has made it possible for it to survive to this day, when in the human species alone it is being produced at the rate of about 10,000 tons a day. The story of the service of chlorophyll would, of course, be more remarkable than this.

Natural selection applies to the survival of the chemical forms of living matter as it does to complex living organisms. These forms, infinitely protean in their variety, survive and persist in so far and so long as they minister to its self-regeneration. It is the principle of survival by service. Function alone gives permanence to structure.

Why is it that what may be termed official physiology takes so little cognisance of the doctrine of evolution?

These branches of biological study appear to follow courses so exactly parallel that they never meet.

The doctrine of evolution digs down into the foundations of scientific philosophy. If a physiologist addressing physiologists ventures to say anything on this subject of supreme appeal to all biologists, it must be in exaltation of the work of those who have approached it from the morphological side, and it may be in hopeful anticipation of the ultimate share in the elucidation of some of its problems to be borne by physiology.

On the part that function plays in the determination of structure it is to be supposed that physiology will ultimately, at any rate, have something more to say. May I submit to the consideration of physiologists certain points in the physiological development of the machinery of the body where, unless I am mistaken, it is possible to detect the operation of function in determining the design of the machine ?

The properties and behaviour of cells result from the properties of the material composing them. When a muscle cell contracts this is, in general terms, a reversible rearrangement of its parts in response to some alteration in the distribution of forces within or about it due to a disturbance from without. Such reversible reaction to adequate disturbance is a property common in the material of which living cells are composed.

In addition to this reversible type of reaction there are irreversible reactions, characteristic of other kinds of cells, and it is what we call connective-tissue cells that I would consider here. There are several kinds of connective-tissue cells, but they are alike in that they produce and discharge into their vicinity material of a characteristic composition ; in some of the commonest this material is chemically collagen, the substance out of which gelatine can be obtained. In course of time these cells come to be embedded in the material which they deposit about themselves and so form one kind of connective tissue. Cells capable of behaving in this way are found, however, which have not yet exercised their faculty ; these fibroblasts are then undifferentiated wandering cells that have found no abiding place in the community in which they have their birth. What it is that makes them settle down and start producing the material in which they come to be embedded has never yet been determined. But the most striking structures to which they give rise are the tendons and aponeuroses that make the muscles fast to the bones, and the ligaments that bind the bones to one another. The material that they deposit is composed of inextensible fibres that lie, in the case of tendons at any rate, so exactly and exclusively in the line of the resultant of the tension set up in the muscle to which they attach themselves, that it is difficult to believe that the disturbance which starts them producing their characteristic secretion is anything else than the pull exerted on them by the muscle fibres to which they are attached ; the recurring external disturbances that produce reversible states of tension in the muscle, indirectly producing in them an irreversible reaction, which consists in the discharge of material that by its inextensibility can transmit the tension along the line of the force that provokes its deposition.

In their simplest form, cells of this kind deposit the wavy fibres in areolar tissue which, when straightened out under the action of a displacing force, set a limit by their inextensibility to the dislocation of the part first affected, and so distribute the action of the displacing force over surrounding areas. It is interesting to note that the origin of cells of this kind has been traced to the mesothelium cells that line tissue spaces and serous cavities, the clefts that make the gliding displacements of parts over one another possible. The deposition of fibrous material seems here, as in the tendons and ligaments, to be the result of reaction to the recurring disturbances set up by displacements, such, for example, as those of the lungs, the alimentary tract, the heart and pulsating vessels, and the deposition occurs in the line of strains set up by the displacing forces. The service rendered by this behaviour of the cells is that the fibres which they deposit, in virtue of their inextensibility, limit the extent of displacement at any one point by distributing it to surrounding parts.

The other component of areolar tissue, the elastic fibres, is similarly produced by other cells. These fibres take a straight course between their attachments ; displacements in the line of their deposition are rendered possible by their stretching, and are recovered from by their elasticity.

The contribution made by such cells to the fabric of the body appears to result from the recurring operation of disturbances, to which they react by depositing fibres along the lines of disturbance.

More striking are the properties of cells upon which the formation of the skeleton depends. The cells that make bone not only secrete fibrous collagen, but they also encrust the fibres with insoluble lime salts, and it has long been subject of comment that the rigid bone that results always comes to lie in the line of prevailing strains and stresses. The analysis of the structure, for example, of the head and neck of the human femur, by Wolff and others who have followed him, shows how strictly this is true. Calculations prove that no particle of bone lies anywhere but where the strains dictate. We can predict with certainty, it seems, that it will be found that bone cells are composed of material that in reacting to physical forces directs, in constant relation to the line of action of those forces, the deposition of the substances which make up this connective tissue. Bone can only arise where strains and stresses set up this reaction, and the greater the strain or stress the denser the deposit. When a bone is fractured many bone cells are dislodged, and in the abundance of nutriment that ruptured vessels supply, these cells, released from their imprisonment, multiply. At first the force of gravity and the twitching of muscles acting on the soft semi-fluid tissues between the broken ends of the bone supply stimuli that are indeterminate in direction, and such reaction as occurs results only in the formation of loosely ordered calcareous fibres ; but even this soft callus gives some degree of rigidity, sufficient to restrict the strains gradually to more and more clearly defined lines along which in proportion a stronger reaction can take place.

Once it is established that bone corpuscles react to strain and stress by discharging collagen, the intimate spatial disposition of which, as well as of the lime salts with which it comes to be encrusted, is determined by the directing forces to which it is exposed ; and once it is recognised that the law of spontaneous regeneration requires that this reaction will persist in proportion to the prevalence of these forces, not only must the gradual replacement of callus by appropriate permanent bone necessarily follow, bone in which no particle persists except it be in the line of constantly recurring stress and strain, but it will also necessarily follow that the position of every spicule of bone in the skeleton, cancellous or compact, is the expression of a physiological reaction to the forces of gravity and muscular tension.

The evolution of the machinery of the connective tissues seems to be not entirely the result of natural selection and the survival of individuals in which this machinery chanced to be of appropriate design. The appearance in early vertebrates of the material that is characteristic of the bone corpuscle seems to have ensured that skeletons would take a shape determined by the direction of the forces to which these corpuscles were exposed, and that the formation of this skeleton is as much a reaction to recurring stimuli as are the reflexes, composite movements and postures characteristic for the species.

This conception of the way in which the vertebrate connective tissues take their shape transfers a large share of the development of the bodily form back into the nervous system, in which the machinery is stored that directs and determines the habitual movements and postures that in reaction to external disturbances are specific. A physiological account of the evolution of the nervous system, one certainly that is based on the chemical constitution and chemical behaviour of its component parts, must seem almost infinitely remote from practical investigation. But the work of Pavlov has made one thing clear: that by a physiological reaction in it, machinery may come into existence which did not exist before. The repeated occurrence of a disturbance at times that are uniformly related to the normal operation of existing machinery results in the acquirement of a new reaction which must require machinery that is new. It is rendered probable, if not proved, that this new machinery is situated in what may be called the growing point of the central nervous system, the cortex of the cerebral hemispheres, the part where all is not 'cut and dry,' where cells retain more of the properties of the developing neuroblasts, the properties that enable them to grow out through the embryonic tissues along courses that make it certain that the maturing organism will behave in a manner true to type. In the formation of a conditioned reflex, two events are made to occur in the cerebral cortex at times which are uniformly related to one another; one of these events, from the constitution of the nervous system, necessarily results in a certain activity of some muscle or gland, the other has been hitherto in no way related to such a result; after many repetitions of the association of these events, it is found that that one which previously had never resulted in this particular activity, comes to have this result as certainly as the other.

But if and when it is possible to trace the origin of structures to functional reactions of cells, and to reactions that depend upon the chemical properties of the cell substance; and if and when this is possible not only in the connective tissues, but also in the nervous system, the functions of which have so controlling an influence on the operation of every part of the body; until it becomes clear that the results of changes in such influence reappear in succeeding generations, the study of functions can have no bearing upon the ultimate problem of biology, the evolutional history of life upon the earth. Pavlov communicated to the International Congress of Physiology in 1923 some results of experiments that he had done upon this subject which, when confirmed, should 'electrify the atmosphere.' Conditioned reflexes that are established only after many—eighty or a hundred—repetitions of the associated stimulus, in each succeeding generation require fewer and fewer repetitions, and in the fourth may be established after only four. In April of this year he wrote to say that owing to other work he had not been able to give the necessary time to confirmation of these results. We are content to wait.

In the great question whether characteristics developed in the life of an individual have any influence on descendants, experimental evidence must come slowly. In what is called parallel induction a step has been taken which is probably of greater importance than is generally conceded. External influences that affect the bodily characteristics of an organism affect also the germplasm in such a way that these characteristics appear in the first, and even, in a less degree, in the second generation born after the external influences have ceased to operate. While such experiments furnish evidence only of a temporary change in the properties of the germplasm, one that may be put down to the lodgment in it of unassimilated foreign matter that is gradually eliminated, the fact that the eternal germplasm has been shown to be subject to temporal influences must not be belittled. A true mutation is not eternal. Our descendants may be able to dispense with hæmoglobin. The hereditary melanism that in certain moths, it is said, can be induced by food infected with manganese, is, perhaps, something more than such parallel induction.

Physiological inquiry is a stream that has many sources; its waters gather from quarters far removed from one another. A marvellous meeting took place in the early years of this century when the forgotten experiments of Mendel came to the surface again, and found corroboration in the cytological studies that from about the same time had pursued their slow obstructed way above ground in the endeavour to elucidate the changes in the nucleus of maturing germ cells. In a resting germ cell the chromosomes form an even number, characteristic for the species; they consist of half that number of pairs of homologues, one of each pair descended from the paternal element in the last zygosis, the other from the maternal. At one of the cell divisions by which the germ cell gives rise to the mature gamete, with half the characteristic number of chromosomes, there occurs a segregation of the two members of each pair so that they pass into different gametes—the exact cytological equivalent of Mendelian segregation of allelomorphic pairs of characters. To-day the study of genetics and of the 'topographical anatomy of the chromosomes,' with its 'groupings' and 'crossings over,' seems to require chemical assistance. It may be that in the lifetime of some of us those confluent streams of thought and experiment are to be joined by yet another that rises in the vast, remote and, as it must appear to some, muddy swamps of physiological chemistry; and it then, forgetting its 'foiled, circuitous wanderings,' will form with them a 'majestic river, brimming and bright and large.'

Francis Bacon and Scientific Method.[1]

By Dr. C. D. BROAD.

II.

THE natural history, selected, arranged, and recorded by the rules described in the previous article, forms the basis on which scientific knowledge must be built. Bacon's next task was to construct a logical instrument by which a knowledge of general laws can be erected on this basis. Plainly the kind of reasoning which is needed is inductive. But Bacon objected both to the order and the form of reasoning which he found in current inductive arguments. Those who use them jump directly from particular facts to extremely sweeping generalisations, and they then deduce propositions of medium generality from these generalisations by means of syllogistic reasoning. Now Bacon's view is that there should be a very gradual ascent from particulars through principles of slowly increasing generality to the widest generalisations. Conversely, there should be a very gradual descent from the widest generalisations through principles of slowly decreasing generality to new particular facts. In the ascending scale each stage covers all the facts below it and extends very slightly beyond them. We then deduce observable, but not hitherto observed, consequences from the hypothesis and see whether they are true. If they are found to be so we can accept the hypothesis and go on to generalise it a little further. Thus the descending scale serves to test the stages in the ascending scale.

Bacon's objection to the form of reasoning employed in current induction was that it made no use of negative instances. It simply argued in the form: "All *observed* S's have been P, therefore *all* S's will be P." Now Bacon's view is that the cause of a given effect cannot be discovered by direct and positive means. It can be discovered only by gradually eliminating alternative possible causes until we are left with a single survivor, which can then be accepted with confidence as *the* cause. In order to discover the cause of a given kind of phenomenon, three sets of tables were to be formed, namely: (1) cases where this phenomenon is present; (2) cases where it is absent; (3) cases where it varies in degree. Now Bacon takes it as axiomatic that what he calls the 'formal cause' of a phenomenon is such that (1) it cannot be absent when the phenomenon is present; (2) it cannot be present when the phenomenon is absent; and (3) it cannot be constant when the phenomenon varies, or conversely. He knows then that the cause must be present in all the cases in the first table. He need not consider, therefore, any factor which is absent from any of these cases. Again, he need not consider any factor that is present in the cases in the second table, for the cause must be absent from all of them. Lastly, he can reject any factor which is constant throughout the cases in the third table. By this method of rejection, and by it alone, Bacon thought it possible to discover with certainty the causes of given effects.

This is Bacon's method in the barest outline. What kind of fact did he hope to discover by it? He tells us that the ultimate aim of theoretical science is to discover 'the forms (or formal causes) of simple natures,' and that the ultimate aim of applied science is to use this knowledge to 'induce on bodies the form of any nature that we may desire it to have.' He draws a sharp distinction between the 'formal cause,' on one hand, and the 'material' and 'efficient' cause, on the other. He assigns the study of material and efficient cause to 'Physics,' and their practical use to 'Mechanics'; whilst he assigns the study of formal causes to 'Metaphysics,' and their practical employment to what he calls 'Natural Magic.' But he recognises that he is here using 'Metaphysics' in an unusual sense. The meaning of all this is the following. By a 'simple nature' Bacon means some perceptible generic physical property, such as colour, temperature, etc. By the 'form' or 'formal cause' of a simple nature he means that which this property is in things themselves apart from their relation to sensitive organisms. Thus, violent and irregular molecular motion would be the 'form' of the 'simple nature' called 'temperature.' Again, periodic variation of electro-magnetic intensity would be the 'form' of the 'simple nature' called 'colour'; and so on. So the Metaphysics of Forms is what we should call Microscopic Theoretical Physics. The propositions of 'Physics,' in Bacon's sense of the word, are what we should call 'empirical laws,' *e.g.* 'if amber be rubbed with flannel it becomes electrified.' Here the 'material cause' is amber and flannel, whilst the 'efficient cause' is the process of rubbing the two together.

Now of course we may know of various practical methods of inducing heat or electricity on bodies when we know nothing of the form of heat or the form of electricity. But Bacon sees that so long as we have merely this rule-of-thumb kind of knowledge our practical control over Nature will be very limited. If, on the other hand, we know the form of a given nature we know that *any* means of inducing this form will induce this nature, and that nothing else will do so. Thus by knowledge of forms, and by that alone, we may be able to produce profound modifications at will in the properties of bodies. This is what Bacon means by 'Natural Magic'; and the syntheses of new substances in organic chemistry would be an example of what he had in mind.

Bacon holds that there is a part of physics and mechanics which is closely connected with metaphysics and natural magic, and constitutes the transition from the former to the latter. This he calls the study of the 'Latent Structure' and the 'Latent Processes' of bodies. He recognises that bodies have an inner microscopic structure too small for our unaided senses to perceive, and that many of their perceptible characteristics depend upon this. He also recognises that what we call the efficient causes of given effects are only isolated outstanding features in processes which are continuous and in the main imperceptible. If we are to understand and control Nature we must turn our attention from the gross structure and changes of bodies to their minute components and processes. Bacon particularly insists that, whilst both of these

[1] Continued from p. 488.

subjects have been neglected, the latter has been more neglected than the former; and yet the dynamical aspect of Nature is even more important than its statical aspect.

It will be interesting at this point to consider Bacon's views about mathematics, for they exhibit his peculiar weakness and strength in a clear light. It is evident that Bacon was no mathematician. He has no theory of mathematical reasoning; he seems to be contemptuous of pure mathematics; and he was evidently unacquainted with the progress which was being made by both pure and applied mathematics in his time. It is noteworthy that in his remarks about Plato, with whom he is not altogether unsympathetic, he never thinks of Plato and his school as mathematicians but always as theologians and moralists. Yet Bacon does repeatedly say that physics cannot progress far without mathematics; and some of his strictures on the excessive worship of mathematics in science are the negative side of an important positive demand. Thus he complains that optics and astronomy have fallen wholly into the hands of mathematicians. When this complaint is investigated it is found to mean that Bacon wants something more than mere geometrical optics and mere descriptions of the courses of the heavenly bodies. He wants a *physical* optics and a *physical* atronomy, which shall deal with the *nature* of light and the *substance* of the stars and planets. His own attempts to supply this want are of very little value, but the demand is a sound one.

Although Bacon held that the proper course for scientific reasoning to take is a gradual ascent from particulars to general laws and a gradual descent from these general laws to new particulars, he was prepared to admit as a subsidiary process the direct passage from one particular to other partly analogous particulars. This he calls *Instructed Experience* (*Experientia Litterata*). He distinguishes various forms of this, of which the following are the most interesting: (1) Varying an old experiment, either by applying it to different but partly analogous materials, or by applying different but partly analogous processes to the old materials, or by varying the quantities or intensities of the factors in the old experiment. (2) Repeating the original process on the product of the previous experiment, as in redistillation. Bacon is careful to point out that we must never assume that an increase in any factor will produce a corresponding increase in the effect, or that the repetition of a process upon its product will increase the effect. (3) Extending a process from Nature to art, from one art to another, or from one part of an art to another part of it. Bacon says that new and useful processes are most likely to be discovered when one or a few men learn to compare the processes of a number of different mechanical arts. (4) Inverting one or more of the factors in an experiment; *e.g.* substituting great cold for great heat. (5) Making one factor gradually more or less intense until the characteristic effect just ceases to take place. (6) Coupling together two cause-factors, each of which has already been tried separately. Here again Bacon carefully points out that we have no right to assume that, because a in the absence of b gives α, and b in the absence of a gives β, therefore ab will give $\alpha\beta$. We may conclude this point of Bacon's doctrine with two highly characteristic quotations: "Though a successful experiment be more agreeable, an unsuccessful one is often no less instructive"; and "Experiments of Light" (*i.e.* those which throw light on the laws of Nature) "are more to be sought after than Experiments of Fruit" (*i.e.* those which lead to results that are of immediate practical use).

I will conclude by mentioning the seven cases in which the senses have to be aided and the kind of help which Bacon suggests. (1) If the object be very distant it must be joined to something which is perceptible at a distance, *e.g.* something that gives a flash or a noise. (2) If it be enclosed in an opaque envelope it must be judged by processes at the surface (*e.g.* feeling the pulse) or by what comes out from it (*e.g.* examination of urine). (3) It may be unable to affect the senses because of its intrinsic nature (*e.g.* colourless gases), or (4) because of its minuteness. The latter difficulty can be avoided by causing it to produce some effect of sensible magnitude (*e.g.* using an air-thermometer to indicate small changes of temperature). (5) Motion may be too slow or too swift to be perceived. In the former case it can be magnified by pointers and similar devices. Bacon does not know how to deal with the latter case. (6) The intensity may be too great for the senses to bear. In this case Bacon recommends the use of reflectors or semi-opaque screens. (7) The senses may be very rapidly exhausted. This happens only with taste and smell. Bacon suggests no remedy for this; but he says that where our senses fail us altogether we may use those of animals (*e.g.* dogs for scent).

Much of the merit of Bacon consists in minute detail, and is lost in a rapid sketch like the present. I think we may sum up his strength and weakness as follows. He was not a great scientist, either practically or theoretically. But he saw many of the essential factors in successful scientific procedure with great clearness, and stated them with admirable force. His method is admittedly incomplete; and no method could accomplish all that he expected of it. The nearest approach to a complete method would be a synthesis of the methods of Bacon and Descartes. But we must go far before we shall find another such combination of wide generalisation, strong common sense, balanced enthusiasm, and pointed eloquence as we find in Bacon.

The Tropical Cyclone.

By E. V. NEWNHAM.

THE cyclone season of the northern tropics is drawing to a close. The accounts of widespread damage to property and loss of life, both in the Gulf of Mexico and in the Far East, that have appeared recently in the newspapers, show that the storms that have already occurred will make this season a memorable one. It is not intended here to deal with these recent events, but rather to present the salient facts about the tropical cyclones of both hemispheres, and to indicate the extent to which these phenomena are understood at the present time.

Like all meteorological phenomena, tropical cyclones show great individual variations from the general type; nevertheless, their general characteristics are sharply defined. In size they occupy an intermediate position between the two other kinds of atmospheric vortex that give rise to winds of hurricane strength, namely, the large cyclonic depression of temperate and high latitudes and the small but excessively violent tornado of the American and Australian type. In all three vortices the pressure of the air is greatly reduced towards the centre, but it is only in the case of the tornado that the pressure becomes too low to be recorded by the ordinary barometer.

The typical tropical cyclone consists of a nearly circular symmetrical whirl, clockwise in the southern hemisphere, counter-clockwise in the northern hemisphere, with a diameter varying from 100 to 600 miles, about a central 'eye,' where the air is nearly calm. The wind is strongest along the margin of the 'eye,' which averages about 14 miles in diameter, and in this region often greatly exceeds a hundred miles an hour. Within the 'eye' the weather is usually fair, but in the zone of strong winds torrential rains occur. The movements of the clouds are in general centrifugal, particularly as regards the higher clouds. The place of origin is in general over the hotter parts of the ocean between latitudes 8° and 12° on both sides of the equator, generally near the equatorial margin of the trade winds bordering the doldrums, or belt of equatorial calms and light winds, but in the case of the storms in the Bay of Bengal and the Arabian Sea, in the region of variable winds and squalls that occur at the transitions between the north-east monsoon of the winter and the south-west monsoon of the summer.

Tropical cyclones form in three zones:

(1) The south-western part of the North Atlantic, around the West Indies.

(2) From the Arabian Sea eastwards so far as the China Seas and western part of the North Pacific.

(3) From around Madagascar eastwards to the Paumotu Islands.

There is, as a rule, one definite season extending over several months and reaching a maximum a little before the autumn equinox, when the ocean is generally at its warmest. Individual seasons differ greatly as regards the number and intensity of the storms that occur, and a connexion has been claimed by some writers between the character of the season and the number and size of the spots on the sun, but a clear relationship for the whole area affected by cyclones has not been established so far.

Cyclones move slowly along paths which also show great variation, but a dominant tendency towards motion along a certain type of curved path, sometimes described as parabolic or hyperbolic, is apparent in all parts of the world where a large mass of land is not so situated as to prevent the storm from passing through its normal life-history.[1] The motion during the first few days is compounded of an east to west drift, and a slight poleward drift, but somewhere between latitudes 20° and 30° (north or south) the motion becomes directly poleward and then inclines towards the east, becoming north-easterly on leaving the northern tropics and south-easterly on leaving the southern tropics. It should be noted that within the tropics the movement is clearly not in accordance with the prevailing winds of the region through which the storm is passing, and is more often than not almost directly opposed to those winds,[2] but on leaving the tropics, when the storm begins to lose its tropical characteristics and take on those of the ordinary temperate 'depression,' the motion, in the case of the cyclones of the North Atlantic and the China Seas, appears as a rule to be that of the prevailing winds, between about latitudes 30° and 50° N.

To return to the important subject of their place and time of origin: whatever the process may be whereby a cyclone begins to form in a region of light and variable winds, there can be little doubt that their whirling motion is due to the deflective force of the earth's rotation. Now this force varies as the sine of the latitude, and is therefore inappreciable for some degrees north and south of the equator; this fact explains why cyclones seldom originate within 8° of the equator. The reason why the time of maximum frequency is normally just before the autumn equinox appears to be that one of the necessary conditions for the formation of a cyclone is a discontinuity between distinct wind systems, and this will be found at a suitable distance from the equator when the equatorial belt of calms (the doldrums) is nearly at its farthest from the equator, *i.e.* not long after the summer solstice, the maximum being retarded somewhat because the greatest warmth of the ocean is normally attained about two months after the solstice. In the case of the Indian cyclones there is a double maximum, one in early summer and the other in autumn; in this case, the controlling factor is clearly the presence or absence of the necessary discontinuity of wind, the warmth of the sea appearing to play little part in fixing the cyclone season.

The above general description of tropical cyclones is based mainly upon a recent memoir of the British Meteorological Office,[3] which is in turn based upon all available contributions to the literature of the subject up to 1920. In the introduction to this work, Sir Napier Shaw attempts to explain the life-history of a tropical cyclone from its birth, as a result of the convection in suitable circumstances of hot moist air, to its death, when, having been transformed into a cyclonic depression of temperate latitudes, it is surrounded by cold dry air on reaching the polar regions. The convectional stage is developed in a very ingenious manner; a number of small convectional 'bubbles' are assumed to unite into a single large 'bubble'; air is withdrawn over a certain area and is 'evicted' in the upper atmosphere; the system quickly acquires the properties of a fully developed cyclone and begins to drift towards the west. In a theoretical section, Dr. H. Jeffreys, regards a combination of the two principal theories so far advanced to explain the origin of cyclones—the 'millpond eddy' and the

[1] The storms of the Bay of Bengal and Arabian Sea appear to behave normally in this respect, but the great land mass to the north does not allow them to survive long enough to follow more than the first third or half of the typical path.

[2] So far as I am aware, this point has not been emphasised hitherto. Its truth rests upon the accuracy of the charts of prevailing wind published in "Bartholomew's Physical Atlas," vol. 3, plate 14, which are due mainly to Köppen.

[3] "Hurricanes and Tropical Revolving Storms." By Mrs. E. V. Newnham. Meteorological Office Memoir, No. 19, 1922.

'convectional' theories—as necessary for a complete explanation.

Since 1920 several further contributions have been made to the literature of tropical cyclones. One deals with the region around the West Indies.[4] Redrawing the tracks of all known cyclones in this area since 1886, Mitchell found that no storm originated over the eastern two-thirds of the Caribbean Sea; many storms originated, however, south of the Cape Verde Islands, and some over the western third of the Caribbean Sea. The deciding factor in this case, as for the Indian cyclones, appears to be the presence or absence of a discontinuity between conflicting winds; such a discontinuity is absent over the eastern two-thirds of the Caribbean Sea. Another interesting fact pointed out by Mitchell is that the cyclone of this area 'recurves' (*i.e.* turns directly polewards) as soon as a trough of low pressure arrives to the north, irrespective of the longitude and time of year.

Another recent valuable publication deals statistically with the tropical cyclones of Australia, without, however, contributing much that is new to the theory of the storms.[5] The last paper to which I shall refer is concerned with the dynamics of the formation of cyclones.[6] Capt. Brunt follows Shaw in regarding simple thermal convection of moist air as the initial stage, the energy for the subsequent violent winds being supplied by the latent heat of condensation of the water vapour that is precipitated in the rising column of air before those winds arise. He lays stress on the importance of explaining how the removal of air from the centre of a developing storm is brought about, and presumes that it is effected by the discharge of the column of rising air into strong upper winds.

The verification or refutation of this and of the various alternative theories of the origin of cyclones that have been brought forward, which space does not permit me to describe, awaits a more complete knowledge of the temperature, humidity, and wind at all levels in the regions of formation of cyclones, which are unfortunately in most cases just where observations of any kind are most difficult to obtain.

[4] "West Indian Hurricanes and other Tropical Cyclones of the North Atlantic Ocean." By C. L. Mitchell. *Monthly Weather Review.* Supplement No. 24, 1924.

[5] "Australian Hurricanes and Related Storms." By S. Visher and D. Hodge, 1925.

[6] "The Origin of Tropical Revolving Storms." By D. Brunt, London Meteorological Office. *Marine Observer*, 1924.

The Reported Conversion of Hydrogen into Helium.

THE current (September) issue of the *Berichte* of the German Chemical Society contains a paper by Profs. F. Paneth and K. Peters on "The Transformation of Hydrogen into Helium," in which they describe in outline how they have succeeded in detecting the presence of very minute amounts of helium, of the order of one hundred millionth of a cubic centimetre, derived from hydrogen which had been absorbed by finely divided palladium at the ordinary temperature.

Theory indicating that this conversion would involve the liberation of much energy ($6{\cdot}4 \times 10^{11}$ cal. from 4 gram-atoms of hydrogen), the author's primary task was to find out if the change would take place without introducing energy from outside, *e.g.* in the presence of a catalyst; and in order to be able to detect very small quantities of helium they elaborated the spectroscopic method in such a way that the limiting amount detectable was 10^{-8}-10^{-9} c.c., or 10^{-12}-10^{-13} gm. Easily liquefiable gas was removed with liquid air and charcoal; oxygen was added and the hydrogen burnt on the surface of the catalyst; water-vapour and excess oxygen were removed with charcoal, and the residual gas was passed into a glass capillary-tube of 0·1 mm. section, which was surrounded with electrode-wires and placed before the slit of the spectroscope. Every precaution was taken to exclude atmospheric helium; the portion of the apparatus that was heated was surrounded with a vacuum-mantle and immersed in water. The presence of neon lines afforded a most valuable criterion of the presence of atmospheric gases; neon was never completely excluded, but the amount present was so small that it did not invalidate the author's main conclusion.

The method is so delicate that the liberation of helium from a mixture of thorium B and thorium C was easily detected, while it is sufficiently sensitive to determine the presence of helium in a few cubic centimetres of natural gas. By its means a natural gas containing 0·19 per cent. by volume of helium was discovered in Germany, and steps have been taken to exploit it commercially. The Canadian natural gas from which helium is extracted contains 0·33 per cent. by volume.

Attempts were made to effect the transformation by submitting hydrogen to the action of a silent electric discharge in an ozone apparatus, and by passing a prolonged and powerful discharge through it in a Geissler-tube fitted with aluminium electrodes; but no success was achieved. Nor was the attempt to produce helium by bombarding certain salts with cathode rays, as suggested by Lord Rayleigh, any more fertile, so that recourse was had to passing fairly large amounts of hydrogen—up to one litre—through heated palladium, in the hope that at the moment of exit a fraction of the protons and electrons would combine to form the helium nucleus. In this case the indications were favourable, but the result was inconclusive owing to the presence of atmospheric neon, and the absence of any proportionality between the strength of the helium lines and the amount of hydrogen that was used.

Finely-divided palladium, either as sponge, 'black,' or palladinised asbestos, was then used to absorb hydrogen at room temperature, and after different intervals of time the hydrogen was combined with oxygen, as previously described. The residual gas obtained after a 12-hours' contact between palladium and hydrogen exhibited four or five lines of the helium spectrum and only a single neon-line; there was also a distinct proportionality between the amount of helium observed and the duration of the time of contact. The activity of the different palladium preparations employed varied considerably; it invariably diminished with repeated use, but both the power of absorbing hydrogen and of effecting the transformation were restored by heating in hydrogen or oxygen, in a mixture of these gases, or in a vacuum. No helium production was observed with palladium preparations that did not absorb hydrogen, although preparations were occasionally obtained that absorbed hydrogen well but gave little of no helium, especially if the hydrogen had been absorbed at a high temperature.

The above results indicated that palladium preparations that have long remained unused at room temperature should contain a little helium (not of atmospheric origin). Examination of a number of such specimens showed that helium was present in all of them, and in particular a specimen of palladinised asbestos, which had been purchased from Kahlbaum two years previously, was found to be relatively very rich, 1 gm. of it containing 10^{-6} c.c. of practically pure helium. After this specimen had been heated to expel the helium, and treated with oxygen for twelve hours, no fresh helium was detected, but at the end of five hours in contact with hydrogen a considerable amount of helium was found. This experiment was performed three times with the same result. The palladium, however, gradually lost its activity; at the beginning it produced helium at the rate of 10^{-8}-10^{-7} c.c. per day; after twenty treatments it became inactive. Its activity was restored, although not to the original degree, in the manner described above. Finely divided platinum is less active than palladium, and the action of pyrophoric nickel is weaker still.

The authors discuss fully the possible sources of error in their experiments, such as the ingress of atmospheric helium, the adsorptive capacity of glass for helium, the conceivable preferential adsorption of helium by palladium, or by asbestos, and the possibility of helium being formed as a radio-active disintegration product of palladium; all of which they consider to be excluded. The hydrogen and oxygen used by them contained less than 0·001 per cent. of air. They were not able to detect any trace of the energy liberated during the transformation, and they point out that the amount set free from the conversion of such small quantities of hydrogen—about 0·28 calorie—would be extremely difficult to detect, and particularly so if thermal changes due to absorption or formation of compounds also take place. They incline to the view that the liberated energy is more likely to appear as radiation, *e.g.* as γ or Millikan-rays, than as heat.

News and Views.

ONE of the subjects discussed at the recent World Power Conference at Basle was the exchange of electrical energy between countries. An interesting example of this interchange of energy occurs between Denmark and Sweden. Submarine cables crossing the Sund Straits transmit power at 25,000 volts and 50,000 volts respectively. When the water supply in Sweden is abundant they carry the excess hydroelectric power to Denmark, and when Sweden suffers from water shortage they convey thermally generated power in the reverse direction. It was pointed out that some countries, Switzerland for example, have great water power resources but yet are very unwilling to export electric power, and set up high tariffs. One of the reasons for their action would appear to be that, in the opinion of some Swiss engineers, Switzerland is destined to become one of the important centres for carrying out electrometallurgical and electrochemical processes on a large scale. In their opinion, the sale of electrical energy abroad helps the establishment of those industries outside their own frontiers and so is not in the national interest. Another objection is that the export of electricity in bulk to foreign countries will gradually subordinate Switzerland to these countries; the foreign capital introduced being conceivably a source of danger. Mr. Niesz of Baden held that these objections have no real foundation. The majority of the engineers present agreed that it is desirable that the authorities in different countries should place no obstacle in the way of a free interchange of electrical energy provided that economic conditions are favourable.

MR. ALAN COBHAM alighted on the Thames opposite the Houses of Parliament on October 1, thus completing his latest flying achievement. In recognition of his services to aviation the King has conferred upon Mr. Cobham the honour of knighthood (K.B.E.). His three long-distance flights are a notable advertisement for commercial aviation. The De Havilland-50 aeroplane, with Armstrong-Siddely "Puma" engine and interchangeable floats and wheels, was designed for flying in countries with undeveloped transport services, where lake, river, or sea offer natural alighting places. An aeroplane of this type was flown to Rangoon and back. The same aeroplane fitted with the more powerful "Jaguar" engine was flown to the Cape and back. Finally, the same aeroplane and engine, after overhaul and fitting of forged "Y-metal" aluminium pistons, was flown to Melbourne and back, floats being fitted as far as Port Darwin, wheels for trans-Australian flying. The structural alterations required for the heavier engine, if any, are not known, but the following are some of the main characteristics:

D.H.-50.	Puma Engine.	Jaguar (Radial) Engine.
Span, 13 m.	6 cyl. (water cooled).	14 cyl. (air cooled).
Surface, 41 m.^{2}	180 kw.	290 kw.
Total wgt., 1770 kgm.	1400 r.p.m.	1700 r.p.m.
Speed, 180 km./hr.	300 kgm. wgt.	360 kgm. wgt.

The last of the three flights was equivalent to flying 800 km. every other day from June 30 to October 1, a high feat of personal skill and endurance, and an equally remarkable record of aeroplane and engine performance.

THE specificity of quinine in curing or relieving the symptoms of malaria has long been known. At the present time, the chief drawback to its use is its cost, due in part to the few areas in which the bark yielding the highest proportion of this alkaloid can be cultivated and in part to the restriction of output. Other drugs have therefore been tried in the treatment of this disease; the other crystalline alkaloids present in the more common variety of bark, quinidine, cinchonine, and possibly cinchonidine, have been shown by Fletcher to be nearly as efficacious as quinine itself (see *Brit. Med. Journ.*, 1926, vol. i. p. 154), and their use therefore should result in a considerable reduction in the cost of treatment. On the other hand, no synthetically prepared compound has so far been found to be of value, but this statement may soon be no longer true if the report from Germany which appeared in the *Times* of September 25 is confirmed. The new drug is called 'Plasmochin,' and has been tested both experimentally in birds and animals and also clinically of endemic malaria and in cases of general paralysis of the insane who have been submitted to the malarial treatment. This treatment consists in infecting the patient with one form of the malarial parasite, and after a week or two curing him with quinine; great improvement of the original symptoms has resulted in many cases. The drug appears to be non-toxic, but caution is expressed as to whether it will replace quinine completely in the treatment of malaria. It has, however, been found to destroy the crescent forms of the 'malignant' tertian parasite within five to seven days. It is possible that it may form a useful adjunct to treatment with quinine or the other cinchona alkaloids.

MR. G. N. HUMPHREYS, of the Uganda Survey Department, has recently led two expeditions to Ruwenzori; he has climbed most of the chief peaks, and made an extensive examination of the range. His first expedition in February of this year was hampered by bad weather, but he climbed Mount Speke and the peak Vittorio Emanuele, and an unnamed peak; and the expedition achieved the first crossing of the range from east to west; it used a pass near Mount Gessi, and discovered three new lakes, of which the largest is two miles long. The second expedition in July had better weather, and the party climbed both the peaks Margherita and Alexandra on Mount Stanley, some of the higher peaks on Mount Baker, and Mount Luigi di Savoia. The expeditions made some natural history collections. A preliminary account of the journeys was given by Mr. Humphreys in a lecture to the Uganda Literary and Scientific Society on August 27 last.

THE British Aquarists' Association has just held its first exhibition in the British Sea Anglers' rooms in Fetter Lane, London, E.C. 4. Judging by the exhibits alone, one would gather that the primary object of the Association is the study of the elegant and comfortable management of freshwater vertebrates, and the provision of expert advice to its members on the construction and maintenance of aquaria. A glance through the *Amateur Aquarist and Reptilian Review*, the official organ of the Association, however, shows that it has much wider biological interests in the structure, habits and life-histories of aquatic organisms generally. In a first exhibition, it was natural that the goldfish family and the quainter and more ornamental water vertebrates should predominate, and we were surprised to find four healthy specimens of such a rarity as Proteus in one aquarium. The exhibition gave special attention to the problem of the respiratory balance. The mechanical method was represented by a recurrent siphon fountain of simple make, an aerating cylinder in which a pump is used to develop air-pressure sufficient for twelve hours' aeration, and a fish aquarium with a sluice under the perforated floor which flushes away the accumulated débris without disturbing the water above. Biologists who prefer the plant-animal balance would be interested to find that such a large variety of aquatic plants from all over the world can now be purchased from dealers in London. The experience of the Association should prove of value to biologists intending to do experimental work with living aquatic animals.

THE work of the Building Research Station of the Industrial Research Department is described in a ten-page pamphlet issued by H.M. Stationery Office. Originally housed in temporary buildings at Acton, this station has now been transferred to permanent quarters at Garston, near Watford, which change admits of considerably increased activities. The highly technical problems involved in modern building are often insufficiently appreciated. These problems refer not only to the purely engineering, constructional, and accessories features contained in most large buildings but also embrace developments in the use of, and a scientific knowledge of, the materials which are popularly associated with ordinary building. To elucidate these matters, the co-operation of the chemist, physicist, architect, and engineer is necessary. As is pointed out, quite apart from the general claims of this industry to a share in the efforts of the scientific worker, the country is involved in huge sums spent upon housing, and it is in the national interest that every effort should be made to utilise science in the interests of real economy in construction. By arrangement with other institutions, the station carries out special researches in addition to the work within its own walls, and is prepared to deal with problems for private individuals at arranged fees. Included in the scope of its work is the collection and co-ordination of current results of investigation from other sources.

DURING the week-end September 24-27, the third conference of the Association of Special Libraries and Information Bureaux was held at Balliol College, Oxford. The immediate object of the Association is the preparation of a directory which, with suitable classification, will direct attention to the sources where special collections of books or other materials have been brought together, whether these be in public libraries or in private collections. This task is a large one, and it is being assisted by a grant of 2000*l*. from the Carnegie United Kingdom Trust. Information bureaux are now being rapidly founded in connexion with many industrial and commercial enterprises, and several of the papers and discussions at the conference dealt with these developments. Papers dealing with the collection of technical information and its utilisation by research associations for the benefit of manufacturers in different branches of industry were also read. The Association is keeping in close touch with foreign sources of information, and is securing liaison with similar developments abroad. At the conference, Dr. de Vos Van Steenjiwk gave an account of the work of the new International Institute of Intellectual Co-operation at Paris. The Association, in preparing the directory and acting as a clearing-house for sources of information, is rapidly placing itself in a unique position to offer valuable service, which will doubtless attract a large membership from professional and business circles. Further information on the Association's work can be obtained from its office at 38 Bloomsbury Square, W.C.1.

DR. D. G. HOGARTH in "The Twilight of History," a lecture delivered as the eighth Earl Grey Memorial Lecture at Armstrong College, Newcastle, in February last, and now published by the Oxford University Press, suggests a new orientation in approach to the problems of the obscure period between the downfall of the second Late Minoan kingdom in Crete and the rise of Hellenism. He does not regard the decadence in art which is to be observed in this period as necessarily implying a set-back in civilisation. While he would agree with the late Sir William Ridgeway in the view that Minos was not 'Minoan' at all, and did not participate in the civilisation named after him, he would not concur in calling him the 'destroyer.' Neither the Achæan nor the Dorian invasion, on his view, was catastrophic. He argues that pre-eminence in artistic products is an accompaniment of an aristocratic regime based upon a subject population of inferior culture, whereas the decadence in artistic motives which follows Late Minoan II., being accompanied by improved technique, for example in pottery, points to the substitution of the artisan for the artist, and a wider diffusion of culture among the people at large. The wider distribution of Minoan products indicates a period of expansion rather than dispersal and the development of an export trade which brought the Greek world into contact with the fertilising influence of the Oriental. Dr. Hogarth concurs in the view that the break up of the Mycenæn Empire was due to the Dorians, but so far from regarding this as the beginning of a 'Dark Age,' he looks upon the isolated communities under hereditary nobles which they founded as the precedent condition of the evolution of the Greek city state. A brief summary does less than justice to Dr. Hogarth's sanity of outlook and his sense of proportion. A careful study of his stimulating lecture might perhaps serve to curb some of the wilder flights of enthusiasm which, apparently, fail to surmount a wall erected somewhere about 776 B.C.

IN connexion with the opening of the reorganised public exhibition galleries of the Imperial Institute, Mr. Arthur M. Samuel, Parliamentary Secretary of the Department of Overseas Trade, addressed a well-attended meeting of head teachers of schools in the London area, held in the great hall of the University of London on the evening of September 28. The Hon. W. G. A. Ormsby-Gore, Under-Secretary for the Colonies, and the Duchess of Atholl, Parliamentary Secretary to the Board of Education, also addressed the teachers. The galleries were opened to the public on the following day. The present system of arrangement, which has been introduced by the new director of the Institute, Lieut.-General Sir William Furse, has as its main object the development of the educational value of the collections, which are planned to illustrate as completely as possible the economic and physical geography of the overseas countries of the Empire. The plan of arrangement which has been adopted for the courts is in keeping with modern ideas in regard to the teaching of geography. Maps and models in relief illustrate the topography and configuration of the country, the distribution of rainfall and other important features. Wherever possible or appropriate, space is devoted to exhibits illustrating the ethnology of the country, and the visitor then passes to a series of show cases in which are displayed selected natural products and manufactures of the country, particular attention being given to new products and developing industries. Complete series of samples for inspection by commercial men and others are to be arranged in special sample rooms. Exhibits illustrating the opportunities for sport are also a feature in certain courts. Full use has been made of the experience gained at the British Empire Exhibition in developing effective means of display, a notable example being the installation of a striking series of finely executed dioramas which portray scenery and natural features, industries, and sport. The scheme has not yet reached its full development in all the courts, but it is clear that the reorganised galleries should prove of great value for teaching purposes and at the same time offer a most attractive display to the general public.

THE *Empire Cotton Growing Review*, vol. 3, No. 3, July 1926, continues to publish interesting accounts of the possibilities of cotton-growing in various tropical dependencies overseas. Mr. G. F. Keatinge, revisiting South Africa in 1925, finds that the production of 1000 bales in 1919, is now 10,000, but would have been more but that many farmers have been discouraged as the result of drought in 1924, excessive rain in 1925, and insect pests at all times. Where, however, cotton is grown continuously on the same land for a series of years, a slow accumulation of pests is to be expected. Cotton prospects in Papua and in New Guinea are discussed by Mr. G. Evans. This number of the journal contains the second part of an article of more general interest to agriculturists, in which Messrs. F. L. Engledow and G. Udny Yule discuss the principles and practice of yield trials. This discussion, which deals with the many difficulties of such yield trials in a critical and yet practical spirit, will be of very general value; the authors state that the form of their paper is the result of their experience in training six generations of 'cotton men' at the School of Agriculture, Cambridge. The Empire Cotton Growing Corporation has also published separately a very full report by Col. C. N. French upon cotton-growing in Nigeria, which is a very interesting discussion of the problems of cultivation, transport, and marketing which arise in a territory where cotton is grown by native farmers.

The report is a striking tribute to the work of the Director of Agriculture, Mr. Faulkner, and his staff.

WE have received a copy of No. 2 of *Continental Metallurgical and Chemical Engineering*, a publication in English, issued by the Dr. Joachim Stern Verlag in Berlin. This periodical is devoted to metallurgical and chemical subjects, and the number received, which is that for September, contains the first part of an article on the cutting and turning of metals, describing important experiments now in progress in the Technische Hochschule of Berlin with the object of determining the forces in action at the cutting edge of the tool and the mechanism of the cutting process. Another subject which is treated in detail is the extraction of radium, vanadium, and uranium from carnotite, whilst the manufacture of ruby glass and the production of synthetic camphor are also topics which receive notice. The review of current literature is, in this number, confined to chemical and metallurgical papers from French and German periodicals. On the commercial aspect, the most interesting article is one describing the movement for the formation of a continental iron and steel syndicate, containing an account of the steps which have been taken in this direction in various European countries, mainly with the object of countering the efforts of the great American steel-marketing organisations. The new periodical is associated with the *Metallbörse*.

THE issue of the *Physikalische Zeitschrift* for July 15 contains a portrait of the late Prof. Otto Lummer and an account of his life and work from the pen of Prof. E. Riecke. Otto Lummer was born in Gera on July 17, 1860, studied mathematics and physics at the Universities of Tübingen and Berlin, obtained the degree of doctor at the latter in 1884 and acted as assistant to Helmholtz at the University until 1887, when he followed his chief to the newly established Reichsanstalt at Charlottenburg. He lectured at Berlin from 1901 until 1904, when he became professor of physics at the University of Breslau. He died suddenly on July 5, 1925. Throughout his life he was a skilled experimenter and an attractive lecturer. The work for which he is best known was done while at the Reichsanstalt—the invention of the Lummer-Brodhun photometer in 1889 and the Lummer plate in 1902, the accurate measurement of the ratio of the specific heats of gases with Pringsheim in 1887–1898, and the measurement of the emission spectrum of a black body also with Pringsheim in 1899-1900, which furnished Planck with the starting-point for the quantum theory. His work while at Breslau was concerned mainly with photometry and its industrial applications.

THE annual report of the Field Museum of Natural History, Chicago, for 1925 contains, as usual, much to make museum workers in Great Britain think. Take, for example, the expeditions during the year: there were three making archæological collections—in Mesopotamia, Egypt, and Peru; two making ethnological collections—in the neighbouring states and in Madagascar; three dealt with various branches of botany—in Peru, Chile, and British Guiana; one sought for fossil vertebrates in Argentina; the Roosevelts led a general zoological expedition through the high lands of central Asia; and four other zoological expeditions worked in Central Africa, Southern Georgia, Saskatchewan and Alberta, and British Columbia. Out of the 21 collectors thus engaged eight were members of the ordinary scientific staff, very nearly one-third of the whole. What one ponders over is how the staff manages to deal with the mass of material that is pouring in. That it does deal with some of it in a highly successful manner is clear from the photogravure plates of various exhibits, such as the man-eating lions of Tsavo and the reproduction of a flowering cactus from British Guiana. These plates, it should be mentioned, are all produced in the museum, and are but one example of its unusual activities. Many solutions of our problem suggest themselves, but one seems certain: the museum must employ many highly-skilled technical assistants. We should like to see a complete establishment list, with the rates of pay.

THE Royal Meteorological Society has lately issued the first three numbers of a new series of publications, entitled *Memoirs*, in which it is intended to include the more technical papers printed by the Society. Such papers have hitherto appeared in the *Quarterly Journal* of the Society, which is circulated to all the fellows, but with the recent growth in the mathematical and technical developments of meteorology, this course has been judged less suitable than the new plan now adopted. The *Quarterly Journal* is intended to make a wide general appeal to those interested in meteorology, and will continue to include a large number of the papers submitted to the Society, together with other meteorological notes and articles: but the more technical and difficult papers, which, for reasons of economy, will be sent only to those fellows who indicate their special interest in these papers and express a desire to receive them, will be noticed in the *Quarterly Journal* only by title or in abstract. The Society, like most other publishing scientific societies, finds the financial difficulties due to increased cost of printing enhanced by the growth in the number of papers presented to it, and this new departure is rendered possible only by the aid of a share of the recently increased Government grant for scientific publications, administered by the Royal Society.

ORDERS of the Committee of Privy Council have been issued by which Dr. Charles J. Martin, Director of the Lister Institute and professor of experimental pathology in the University of London, and Sir Frederick G. Hopkins, professor of bio-chemistry in the University of Cambridge, are appointed members of the Medical Research Council into the vacancies caused respectively by the death of Lieutenant-General Sir William B. Leishman and by the retirement of Prof. T. R. Elliott.

MR. W. R. THOMSON, formerly a member of the staff of the Royal Agricultural College, Cirencester, has been appointed by Messrs. Fertilisers Sales, Ltd., Adelaide House, King William Street, London, E.C.4, to be director of propaganda for calcium cyanamide in Ceylon.

THE Chemical Society is publishing a series of photographs of eminent chemists, reproduced by a photo-lithographic process. So far eight are available: Bunsen, Emil Fischer, Hofmann, Mendeléeff, Pasteur, Sir William Perkin, Ramsay, and Roscoe. The portraits should be admirable and inspiring decorations for chemical and other laboratories.

FROM the fifty-sixth annual report of the Newport (Mon.) Public Libraries, Museum, and Art Gallery, for 1925–26, we learn that a new building for the Museum and Art Gallery is as urgently needed and as far off as ever. Meanwhile valuable objects of art and science, which should find a home in Newport, are directed elsewhere, and the educational activities of the Museum are hampered for want of a lecture room.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A medical practitioner as bacteriologist for the City of Salford—The Medical Officer of Health, 143 Regent Road, Salford (October 11). An assistant lecturer in the principles of teaching (logic, psychology and ethics) at the Glasgow Training Centre of the National Committee for the Training of Teachers—Director of Studies, Training Centre, Jordanhill, Glasgow (October 16). An assistant pathologist at the Royal Free Hospital and London School of Medicine for Women—The Secretary, R.F.H., Gray's Inn Road, W.C.1, or The Warden and Secretary, London School of Medicine for Women, Hunter Street, W.C.1 (October 18). A professor of mathematics, a reader in physics and a reader in chemistry at Raffles College, Singapore—The Board of Education or the Scottish Education Dept., Whitehall, S.W.1 (October 22). A lecturer and demonstrator in chemistry and a lecturer in pharmacy in the University of Sydney, New South Wales—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (October 30). An Editor for "Science Abstracts" having a knowledge of physics, electrical engineering and foreign languages—The Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2 (November 8). An assistant curator in zoology in the Bristol Museum and Art Gallery—The Director (November 15). A State mining engineer to the Western Australian Government—The Agent-General for Western Australia, 115 Strand, W.C.2 (November 30). The "J. C. White" lectureship in bacteriology in the Queen's University, Belfast—The Secretary (December 1). A teacher of biology at Gordon College, Khartoum—The Sudan Government Offices, Wellington House, Buckingham Gate, S.W.1 (marked "Teacher of Biology"). A warden of the Ellis Llwyd Jones Hall of Residence for Women Students, Victoria University of Manchester—The Registrar of the University. A lecturer in mathematics at the Chelsea Polytechnic—The Secretary, Chelsea Polytechnic, Manresa Road, S.W.3.

Our Astronomical Column.

THE METEORIC PHENOMENA OF SEPTEMBER 6.—Mr. W. F. Denning writes that, with reference to the meteoric phenomena observed on Monday, Sept. 6, though there were probably two different meteors seen at about $20^h\ 45^m$ G.M.T., the various observations are not sufficiently definite to determine the real paths with certainty except in one case. This refers to the great fireball which was directed from the north-east and passed over Yorkshire from the North Sea to disappear finally over Matlock, Derbyshire. Its height was from 60 to 28 miles, path about 133 miles, and velocity 15 miles per second. The radiant point was near ϵ Persei over the north-east horizon at the time of the fireball's appearance.

Statements have appeared in the newspapers that a London photographer released a number of gas balloons earlier in the same evening. Those were so arranged as to acquire altitudes of about 5000 feet and to explode finally with great noise and light. The originator of the scheme alleges that he sent the balloons up as an 'amusement' and 'experiment,' and claims that the supposed meteors and curious flashes observed on the same evening were the products of his experiment. This claim cannot apply to the Yorkshire fireball at least, which gave a dazzling illumination, occasioned loud detonations, and caused buildings to vibrate as during an earthquake. A small gas bag could scarcely induce results of this character.

DESIGN OF A 25-FOOT REFLECTOR.—There is no finality in telescope design, and Mr. F. G. Pease, of Mt. Wilson Observatory, pronounces that the making of a 25-foot mirror is quite within the bounds of possibility, and gives a design for such an instrument and its dome in *Publ. Astr. Soc. Pacific* for August. He makes the focal length only 3·3 times the aperture, so that the dome has only twice the span of that of the Hooker telescope. The estimated cost is 12 million dollars. Various materials are suggested for the mirror: glass, pyrex, obsidian, stainless steel; Mr. Pease is not without hope that an alloy may be found with a low coefficient of expansion like invar, but superior in reflective power.

The proposed instrument would carry a 70-foot interferometer. Mr. Pease considers that the climate of Mt. Wilson would permit of the effective use of such an instrument on nearly as many nights as the 100-inch Hooker telescope.

CATANIA OBSERVATORY.—This observatory undertook the photography of the zone $+46°$ to $+55°$ of the Astrographic Catalogue. The printing of its results is much in arrears, owing to shortage of funds since the War and frequent changes of directors (A. Ricco died in 1919 and B. Viaro in 1922), but the appearance of Vol. 2, Part 2 will be welcomed. This extends from declination $+47°$ to $+49°$, and from R.A. 3^h to 6^h. There are 48 pages of catalogue, with an average of about 120 stars on each, going down to mag. 12·2 (photographic). The information given is fuller than in most astrographic catalogues, R.A. and decl. being given for all stars (to $0{\cdot}01^{sec}$ and $0{\cdot}1''$), also meridian positions and spectral types for all stars for which they are available. There is difference of opinion as to the advisability of thus increasing the size and cost of the work, but there can be no question that it makes the catalogue much more convenient for reference.

The *Annuario* of the Observatory for 1926 contains drawings of sunspots and prominences by G. Favaro, and of Mars (opposition of 1924) by M. Maggini. The latter show an unusual number of small round markings, both bright and dark; some of the former may be clouds. A bright bridge crosses Syrtis Major, a feature that others have noticed at times.

Research Items.

Analysis of Prehistoric Bronze.—Mr. A. Leslie Armstrong publishes, in *Man* for September, a number of analyses of bronze implements and founder's metal made by Prof. Desch in connexion with the work of the Bronze Age Implements Committee of the British Association. A palstave found at Windsor in 1864, formerly in the Hull Museum and now in the Ashmoleum Museum, Oxford, was one of the most interesting of the objects examined. Its metal had an abnormal appearance, and on analysis it proved to contain so much oxygen and sulphur that the metal was "hopelessly brittle" and could only be regarded as a founder's failure. The figures were copper 78·79, tin 16·49, nickel 0·49, lead 0·09, sulphur 0·68, total 96·54. Three implements from a hoard found at Westcroft, Shelf, near Halifax, were also brittle owing to excess of sulphur, the analysis of one revealing 1·50 of sulphur, copper 86·32, tin 12·14. The Everthorpe Hoard of thirteen socketed celts, a gouge, and three lumps of metal, now in the Hull Museum, was also examined, and revealed the surprising fact that the metal was practically pure copper, a condition unusual in English objects. The celts are unfinished foundry specimens and the analyses of three samples were practically identical, showing 98 to 99 per cent. of copper. A socketed celt, however, from the same hoard showed the remarkable result of copper 66·88, tin 10·54, and lead 22·36. Such an amount of lead is probably unique.

The 'A' Cemetery at Kish, Mesopotamia.—The Field Museum, Chicago, has undertaken the publication of the technical description of the pottery, metal, and stone implements, and other details of the more material side of the archæological discoveries of the Field Museum-Oxford University Expedition to Kish. The first part, Vol. 1, now issued is by Mr. E. Mackay, the excavator, and deals with the finds in the 'A' cemetery, close to, and south of, the Ingharra series of mounds. This site was partially excavated between January and March 1924, when thirty-eight graves were opened. The finds presented many points of particular interest. On the site, which awaits further excavation, was a large building of plano-convex bricks, which had afterwards been enlarged, and after a considerable lapse of time the addition was repaired. The burials are dated at about 3000 B.C., when the buildings had fallen into a state of decay. The skeletal remains show that though the legs were bent, the bodies were not interred in the 'crouched' position and there is no indication of a rule of orientation. The pottery includes new and important types, the most striking being the handled form which is unique in Mesopotamia or elsewhere found in nearly every grave. It is made in three pieces skilfully joined, the chief peculiarity being the handle, which is hollow, and has the face and breasts of a female in clay applied to it. It is clearly in origin a spout, as in some cases the cavity of the handle communicates with the interior of the jar, and in no case is the handle actually secured to the rim. Nearly every grave was supplied with a pottery brazier made in two pieces. Nothing quite like them has been found excepting the Hittite 'champagne cups' of Bronze Age date, and a vessel from the prehistoric burials of southern India conjecturally dated 2500 B.C. Copper implements were numerous, especially knives and daggers. They were beaten out of thin sheet metal and as they seem too light in weight for actual use, were probably made for funerary purposes. Curious implements of sickle shape of which the use is difficult to determine may, it is suggested, have been used as strigils. The designs on the seals, as usual, throw light on the general culture of the period. The fauna represented suggests a semi-arid climate such as that of South Africa, and it is interesting to note that an antelope apparently was domesticable.

Forest Ecology in Sweden.—The Swedish Institute of Experimental Forestry in 1923 acquired two forest areas in Västerbotten, northern Sweden, for scientific studies. Kulbäcksliden is about four square miles in area, and Svartberget is slightly smaller. In "Excursion Handbook" No. 11 of the Institute, the geology and vegetation of these forest areas are described by Messrs. O. Tamm and C. Malmström, with maps of the soil and vegetation formations. Over the greater part of the areas the plant communities have suffered no interference by human agency. The predominant tree is the Scots pine, but there is a considerable proportion of spruce. From an investigation of fossil pollen in peat bogs M. Malmström believes that pine and birch used to prevail, while spruce was absent or rare, and did not become an important forest tree until perhaps four thousand years ago. Spruce pollen increases rapidly in amount in later peat deposits, suggesting a rapid invasion of this tree. At the same time elm and lime disappeared. Spruce seedlings have an advantage over pine and birch in needing very little light. Thus as competition and crowding increases, the spruce is best able to hold its own. On the other hand, spruce has less resisting power than pine against forest fires, so that after a fire the pine again has a chance until eventually crowded out once more by spruce.

Kapok.—The *Bulletin of the Imperial Institute*, vol. 24, No. 1, 1926, has an article, with bibliography, upon the prospects of the production of this fibre within the British Empire. The tree producing kapok, *Eriodendron anfractuosum*, belongs to the natural family Bombacaceæ and occurs in many tropical parts of the British Empire, but practically the entire commercial supply of the fibre is obtained from Java. On a relatively small scale it has been cultivated with success in Ceylon. The hairs in kapok are attached to the inner wall of the capsule and not to the seed itself, so that the separation from the seed is much more easy than in the case of cotton. The hair cells are full of air and very light, and as they are unpermeable to moisture they are used throughout the world for the manufacture of life belts and similar appliances, but the chief use of kapok at present is for stuffing cushions, mattresses, etc. Hitherto great difficulty has been experienced in spinning kapok, owing to the smooth, slippery surface of the fibre; when this difficulty is overcome the yarn may not be strong enough for some purposes, but in the production of good non-conducting fabrics and in other directions kapok may find an extensive field of employment. The seed is rich in oil, and in the Dutch East Indies forms an important source of revenue. Cultivation of the kapok tree seems to offer few difficulties in a suitable climate, and propagation, either from seed or cuttings, is a simple matter.

Fungi.—The Ministry of Agriculture and Fisheries has published 25 coloured plates, of a few (sixteen) of the edible British fungi and also of nine of the more dangerous poisonous species (London: H.M.S.O.). This handbook replaces a former edition, now out of print; names and description have been brought up-to-date, and seven new plates inserted, four of more common species in place of rare species now omitted, three as more representative illustrations of the same species than the figures in the former handbook. The illustrations are clear and the description as non-technical as possible, but it is doubtful whether it is advisable for any but the competent mycologist to range so widely in his diet of fungi. The handbook is very cheap at 3*s*. in S/Cloth Boards or 2*s*. 6*d*. Quarter Boards. In the *Annals of the Royal Botanic Gardens, Peradeniya*, vol. 10, part 1, T. Petch continues his "Additions to the Ceylon Fungi," whilst the *Kew Bulletin*, No. 7, 1926, contains an account of the Fusaria of Jamaica, by C. G. Hansford. Dr. Paul A. Murphy and Robert M'Kay have a paper upon the downy mildew of onions (*Peronospora Schleideni*, Unger) in the *Scientific Proceedings of the Royal Dublin Society*, vol. 18 (N.S.) No. 22, 1926. Perennating mycelium in the bulbs seems to be the main method by which this disease hibernates in Ireland. In the *Transactions of the Royal Scottish Arboricultural Society* Dr. Malcolm Wilson, with collaborators, publishes brief notes upon *Rhizosphæra Kalkhoffii* Bubák, as a cause of defoliation in conifers, and upon *Rhabdocline Pseudotsugæ* Syd., a new disease of the Douglas fir in Scotland.

BLOCK LAVA AND ROPY LAVA.—It is well known that there are two contrasted types of lava flows known as *aa* or block lava and *pahoehoe* or ropy lava. The rough surfaces of the former are moderately crystalline, whereas the latter is covered with a smoother layer of glass which varies in vesicularity from a continuous solid to a froth. A flow frequently starts as *pahoehoe*, especially where the rate of flow is not too high to permit skins of chilled glass to form over the surface, while further on *aa* is formed. This may occur where there is an increase of slope giving turbulent conditions, or when the underlying lava stream has begun to crystallise so that it can no longer advance in a completely liquid state. At Mauna Loa most of the *pahoehoe* is formed during the declining phases of activity; crusts then form over the lava, which flows slowly in tunnels and advances by pushing out bright toes along the front of the stream. These in turn rapidly crust over, and the conditions are very different from the raging torrents with which the flank eruptions often begin. Experiments carried out by O. H. Emerson, and recorded in the *Am. Journ. Sci.* for August, together with many pertinent field observations, converge in showing that *aa* lava is essentially due to crystallisation of the mass while it is flowing. It is concluded that the controlling factors in determining the final appearance of a lava flow are mainly mechanical, such as the thickness and viscosity of the flow, its degree of crystallisation at any given time, and its velocity. It has been thought that *aa* is formed by containing and releasing more gas than *pahoehoe*, for the bursting of vesicles often contributes to the roughness of a lava surface. Dr. Jaggar, however, is quoted to prove that there is no evidence as to which of the two forms, if either, gives off the greater quantity of gases.

ARCHÆAN ROCKS OF SOUTHERN INDIA.—In his presidential address to the Geological Section of the Indian Science Congress of 1924, now published in the *Records of the Mysore Geol. Dept.*, 23, 37, 1926, Dr. W. F. Smeeth discusses the sequence and origin of the gneisses and associated rocks of Mysore. He adheres to his view that the chloritic and hornblendic rocks of the Dharwar group are the oldest of the complex, and that the gneisses, charnockites and granites are successive intrusions of later dates. Nevertheless, no sign has been detected of any old land surface or basement rock on which the oldest Dharwars could have been laid down or erupted. This failure has led to the hypotheses that the original underlying floor, together with the base of the Dharwars themselves, have been re-fused, or that they have foundered into the depths after having been stoped away by a magma rising from deeper sources. The upper or chloritic division of the Dharwars shows as a whole more folding and shearing than the lower or hornblendic division, and the contact relations indicate that the latter are, for the most part, intrusive towards the former. Confirmatory evidence is found in the structural relations of the banded quartz-ironstones that are developed among the chloritic schists. Acid intrusions which have been thought to be offshoots from the later Champion Gneiss are stated to be more abundant in the upper division than in the lower, and this discrepancy is met by the suggestion that some of them are associated with a period of granite intrusion still earlier than that of the Champion Gneiss, and also earlier than the intrusion of the hornblendic series.

BRAZILIAN METEOROLOGY.—The observations taken at the Central Observatory at Rio de Janeiro in 1921 are tabulated in full in the *Boletin Meteorologico* published by the Ministry of Agriculture. They are followed by a summary of the observations taken at some 80 other stations, and rainfall data at 25 other stations. In an appendix there are added the data obtained from various private observatories, owned mainly by railway and mining companies. The volume contains detailed rainfall maps, so far as statistics permit, for every month in the year. The lack of data in the far interior is noticeable in these maps, which show only five stations in the basin of the Amazon and its main tributaries. On the coast, however, the stations are numerous.

RECURRING MAGNETIC DISTURBANCES.—Largely through the work of Maunder and Chree, the '27-day recurrence tendency' is one of the most firmly established facts of terrestrial magnetism: the phrase denotes the tendency for a day following or preceding, at an interval which is an integral multiple of 27 days, a day of marked magnetic disturbance or calm, to share the same characteristic in diminished measure. The tendency is attributed to the association of magnetic disturbance with corpuscular emissions from particular disturbed regions of the solar surface: if on a given day such a region is suitably disposed towards the earth, so that its emissions impinge on the earth, then 27 days later, in consequence of the solar rotation, it will recur to approximately the same aspect relative to the earth, and if still active there will be recurrence of terrestrial magnetic activity at this interval; it is known that particular solar regions often remain disturbed for the duration of more than one solar rotation-period. The same hypothesis applies, *mutatis mutandis*, to days of magnetic calm, which are naturally associated with notably calm regions on the sun's surface. In *Terrestrial Magnetism*, June 1926, W. J. Peters and C. C. Ennis use the Ebro observations of 1910–1924 to prove that earth currents exhibit the same recurrence-tendency. This was to be anticipated, since it is almost certain that these currents are induced in the earth by the variations in the earth's magnetic field (themselves originating in electric currents situated in the atmosphere); it is satisfactory, however, to have this anticipation confirmed.

THE ACOUSTICS OF BUILDINGS.—As the result of experiments which have been carried out at the National Physical Laboratory, Teddington, during the last two or three years, architects can now be told what will be the acoustical properties of any hall designed by them, before it is erected. The apparatus used in the predetermination of these properties is described by Dr. A. H. Davis and Mr. N. Fleming in the September issue of the *Journal of Scientific Instruments*. For the effects of floor, ceiling, side walls, and galleries, a small model in hard wood is made, the end walls being omitted. A spark from an electric machine is made to pass between two electrodes placed in the model at the point at which in the hall the sounds are produced, and, after a short interval, a second spark is made at a point in the model which corresponds to a point behind the source of sound in the hall. The position of the sound wave due to the first spark is shown by the shadow it casts on a photographic plate placed in the model at a point corresponding to one behind the back wall of the hall. By changing the interval between the two sparks, the sound waves before and after reflection are followed.

THE CATALYTIC DISSOCIATION OF CARBON MONOXIDE.—The reversibility of the reaction $CO_2 + C = 2CO$ was demonstrated by Deville in 1863, and although numerous experiments on the thermal decomposition of carbon monoxide, alone or in the presence of catalysts, have been carried out since that time, the existence of this equilibrium at comparatively low temperatures has but recently been observed. The minimum temperatures at which various catalysts cause the decomposition of pure carbon monoxide were determined by J. Cleminson and H. V. A. Briscoe in a series of experiments described in the August issue of the *Journal of the Chemical Society*. The pure gas was heated in a durosil vessel, connected with a mercury manometer, in the presence of the catalysts, the diminution in volume serving to measure the extent of decomposition. The temperatures at which the decomposition began were 300°, 290°, and 250° for carbon, magnesia, and alumina respectively.

FUMIGATION WITH HYDROCYANIC ACID.—Fumigation with hydrocyanic acid gas is the subject of *Science Bulletin*, No. 46, published by the Department of Agriculture of the Union of South Africa, which details the work of B. J. Smit and T. J. Naude on the distribution of the gas in a tented enclosure. In order to find the conditions for the most efficient fumigation, samples of the gas from different parts of a treated brick-chamber were drawn through potash solution and the hydrocyanic acid concentrations estimated. When the pot method is used, it is found that, under the influence of the heat of reaction between the hot sulphuric acid and the sodium cyanide, the gas rises to the top of the chamber and descends along the walls to the floor, the dose being in excess of the theoretical for the first few minutes. In fumigations with liquid hydrocyanic acid, the distribution of the gas depends on the nature and area of the surface on which the liquid is poured, but when the evaporation is aided by heat the results resemble those obtained by the pot method.

EKA-CÆSIUM.—Various attempts have recently been made to isolate eka-cæsium, the hitherto missing element 87. Assuming that $MsTh_2$, an actinium isotope, might undergo dual disintegration, and emit a small number of α-particles in addition to its normal β-ray disintegration, O. Hahn recently attempted to detect the missing element. He concluded that eka-cæsium, provided it has a half-value period of not less than a few hours, does not result from the disintegration of $MsTh_2$. Using the scintillation method, G. Hevesy has also investigated the problem of the missing element by counting the α-particles emitted by RdTh during its growth from $MsTh_2$. His results indicate that the fraction of $MsTh_2$ atoms which disintegrate under emission of α-particles is certainly less than 1/200,000. In a recent paper (*Phys. Zeit.* 27, p. 531, August 15, 1926), O. Hahn and O. Erbacher have carried the investigation a stage further. They used strong $MsTh_2$ preparations, of strength equivalent to 24-32 mgm. radium, which they freed completely from isotopes of radium, lead, and bismuth in the presence of iron, after which cæsium nitrate was added, and the $MsTh_2$ quantitatively separated from it. The cæsium was then precipitated, carefully washed and dried, and transferred to an electroscope. The measurement of its activity was commenced about thirty minutes after separation of the $MsTh_2$. The residual activities were probably due to traces of $MsTh_2$, and were so small that the authors conclude that if eka-cæsium is produced from $MsTh_2$ and has a half-period within the limits of a few minutes and ten years, the branching ratio is not greater than one in ten millions. By the observations of the β- and γ-activities of their purified $MsTh_2$ preparations during a period of 50 hours, four accurate decay curves of $MsTh_2$ were obtained, and these yield a mean value of 6·13 hours for the half-period of $MsTh_2$ ($\lambda = 0{\cdot}113$ hour^{-1}). This result agrees fairly well with the earlier determinations, but indicates that the value $T = 5{\cdot}95$ hours obtained by W. P. Widdowson and A. S. Russell is distinctly low.

AN ARABIC TREATISE ON ALCHEMY.—Additional information on the "somewhat shadowy figure" of Abu 'l- Qāsim al- ' Irāqī, an Arabic alchemist of the 13th century, whose work "Al- Muktasab" (Arabic text and English translation, Paris 1923) was published by Mr. E. J. Holmyard, and was reviewed in NATURE (Aug. 30, 1924, p. 307), is now available in the July number of *Isis*. Mr. Holmyard here gives translations of parts of other works of Abu 'l- Qāsim, in which (as in the first treatise) the influence of Alexandrian writers is very clear. In a list of secret names ("Decknamen") of materials, many are those "used by the Greeks." Among the names of mercury is "liquid gold" (which Mr. Holmyard does not comment upon). The Greek name is "liquid silver" (χυτὸς ἄργυρος in Aristotle, the earliest mention), but Ktesias mentions an Indian "liquid gold" (ὑγρὸς χρυσός). The elixir is called *al-tiryāq* (οηριακή, a nostrum invented by Andromachus of Crete, physician to Nero, which Sprengel says "was later applied without distinction to all the kinds of diseases"). Supposedly Greek names, which are obviously greatly disfigured, are left by Mr. Holmyard without comment. Among these are *halinus* for hæmatite (? *al īmus*, αἱματίτης); *isqūnās*, purified sulphur (? from φεῦγον, the sulphur being sublimed); *mughlīs*, salt of urine (probably made up from ὄμιχμα and ἅλς); *faluzabalis*, white lead (perhaps containing λιθάργυρος; the name 'Αφροσέληνον suggested by Mr. Holmyard seems improbable); *harfatis*, copper scales (Ruhland, *Lex.* 29, says *alfatida* is "cuprum ustum"); *badis*, trona (Ruhland, 100, *barach panis* is "nitrum salis"), *raus*, sulphur, etc.

Jubilee of the Mineralogical Society.

THE opening of the Jubilee Celebration of the Mineralogical Society on Tuesday, September 21, was preceded by a very successful week's excursion to Cornwall under the leadership of Mr. Arthur Russell, which was attended by about eighteen members and guests.

On Tuesday, September 21, an informal gathering in the Mineral Gallery of the British Museum (Natural History), South Kensington, was followed by a visit to the Imperial College of Science, where was shown a series of exhibits in the Geological Department, and Prof. H. C. H. Carpenter exhibited and gave an account of the large crystals of aluminium and other metals that he has succeeded in making.

The afternoon began with a most interesting visit to the Royal Institution, where Sir William Bragg and his assistants showed models of crystals and the results obtained by the X-ray analysis of minerals. Sir William Bragg also took his guests over the Institution and showed the historic laboratories of Faraday, and the apparatus employed by him and by other famous investigators. Later in the afternoon, at the Jermyn Street Museum, Sir John Flett and the Museum curators exhibited the mineral and other collections, the library, and map-room, and entertained the visitors at tea.

The formal reception took place in the evening of Tuesday at a conversazione held by kind permission in the rooms of the Geological Society at Burlington House. Here Mr. Campbell Smith had arranged an interesting collection of apparatus and specimens. The latter included a beautiful set of gold nuggets, got together by one of the oldest members of the Mineralogical Society, Prof. Liversidge. The apparatus, consisting of goniometers, refractometers, etc., all of British workmanship, was mostly of recent design, but part was old and of historic interest from its association with earlier workers. After the formal reception the President delivered a short address dealing with the history of the Society, its relations with other kindred societies, and the main lines of work which it has accomplished and published.

The exhibits at the Geological Society's rooms were on view during the following day, September 22, and were visited and examined by many who had had too little opportunity on the previous evening. By kind permission of the Provost of University College, parties were also able to visit at 134 Gower Street the beautiful collection of Vesuvian rocks and minerals formed by the late Dr. H. J. Johnston-Lavis, and bequeathed by him to the University of London. In the afternoon the party was received at the Imperial Institute by Sir William Furse and Sir Richard Redmayne, who gave an account of the collections, and the intention of those in charge to make the Institute a new educational instrument with the definite aim of illustrating the products and characteristics of the various parts of the British Empire. The party then proceeded to the British Museum (Natural History), where they were received by the Trustees, the Assistant Secretary, and the Keepers of Mineralogy and Geology, and were shown some of the chief features of the Mineralogical Collections. Afterwards the party were photographed and entertained at tea provided by the Government.

The London part of the celebration closed with a dinner at the Connaught Rooms, at which about seventy were present, the chief speakers being Dr. Harry von Eckermann (Sweden), Prof. Paul Niggli (Switzerland), Prof. F. Wigglesworth Clarke (U.S.A.), Prof. J. L. H. Borgström (Finland), Prof. F. Rinne (Germany), and Dr. H. Ungemach (France), for the foreigners, and Sir Henry Miers, Sir Thomas Holland, Sir John Flett, and the President of the Mineralogical Society, for the hosts.

Letters were communicated, bearing messages of congratulation from many foreign societies which had been unable to send representatives to the gathering, among the most interesting being those from Prof. Victor Goldschmidt of Heidelberg, from Prof. Paul Groth, Prof. A. Lacroix, Prof. E. S. Dana, the veteran Gustav Tschermak, Dr. H. Michel, Prof. J. Morozewicz, Prof. F. J. Becke, Prof. F. Zambonini, and the Mineralogical Societies of Vienna, Russia, Hungary, and America. Addresses were read and presented from the Geological Societies of Poland and Cornwall, and it was resolved to send telegrams of greeting to Prof. Tschermak, Prof. Dana, Prof. Goldschmidt, and Prof. Groth representing the oldest of the honorary members of the Society, and to Mr. B. Kitto, Prof. A. Liversidge, Dr. R. Pearce, and Mr. C. J. Woodward, veteran ordinary members of the Society, the last being one of the two survivors of the Crystallological Society.

On the following morning about a dozen left Euston for the north of England with Prof. A. Hutchinson of Cambridge, to study the Shap and Carrock Fell areas, the Alston district, and other famous mineral localities. The excursion closed at Cambridge on Friday, October 1, with visits to the Mineral Laboratories of the University and of Dr. A. E. H. Tutton.

The President of the Mineralogical Society, Prof. W. W. Watts, in his presidential address, extended a very warm welcome on behalf of the council and members of the Society to those who had come from far-distant parts of Europe and America to join in the celebration. He pointed out that the Society was not the first of its kind in Great Britain, but had been preceded in 1799 by a body who formed "The British Mineralogical Society," and continued active for seven years when they rejoined the Askesian Society, a selected number of which formed the nucleus from which the Geological Society grew. The minute book of that old Mineralogical Society is still preserved in the Science Library, and by the kind permission of Sir Henry Lyons was exhibited at the conversazione.

In the same year as the Mineralogical Society was founded, a more academic body, at first called the Crystallometric Association and afterwards the Crystallological Society, was formed, but it amalgamated with the Mineralogical Society in 1883, bringing with it such men as Maskelyne and Lewis, Fletcher and Miers, who afterwards served as presidents. As a result of this happy combination, the Mineralogical Society was free to publish crystallographic as well as its other purely mineralogical work.

The Society was fortunate in securing Henry Clifton Sorby as its first president and keeping the "Father of Petrology" in the chair for three years. His influence on the Society was very great, both in the optical and microscopic work which he founded, and in adding the advancement of the knowledge of petrology as one of the objects of the Society.

Sorby was followed by a line of presidents each of whom rendered conspicuous service to the science and to its Society; Heddle, with his long list of works on Scottish mineralogy; Bonney, with his series of papers on rocks and rock-forming minerals; Hudleston, of wide travel and critical instinct; Scott, with his broad chemical knowledge and his service to the finances of the Society; Fletcher, who not only wrote a series of masterly papers on meteorites but also revolutionised crystal-optics by his conception of the optical indicatrix; Maskelyne and Lewis, professors of mineralogy at Oxford and Cambridge respectively, famous for their crystallographic work,—to mention only some of those who are no longer with us.

The work of these men reflects that of the Society. Always there have been pure mineralogical papers dealing with mineral types or mineral groups, topographic papers concerning areas at home and abroad famous for their unique or abundant minerals, and petrographic papers dealing with the naturally occurring associations of minerals. These have depended upon chemical analysis, measurement of crystals, and determinations of optical characters as revealed by the microscope and other optical instruments.

In addition to this there have been a number of papers devoted to the mathematical aspects of crystallography, to the expression of internal structure by outward form, to the physiology of mineral growth, repair, and destruction, to the minerals used as gems or for other economic purposes, their associations and genesis, and of later years to the atomic and molecular structure of crystals as revealed by X-ray analysis.

The organ of the Society, the *Mineralogical Magazine*, has appeared regularly throughout the life of the Society and, in addition to original communications read at the meetings, has contained abstracts and reviews, and lists of new mineral names. During the last few years (since 1920) the Society has published sections of mineralogical abstracts. These give concise accounts of mineralogical papers and works published elsewhere, and have been of the greatest service to all workers in mineralogy, crystallography, and petrology. Indeed, the Society has never been more active than at present, and there is every promise of a brilliant and useful future.

Classification of Amœbæ.[1]

THE purpose of the memoir before us is to set forth a description of 39 new species and 11 new genera of Amœbæ and to propose a classification of Amœbæ. That a revision of the systematics of Amœbæ is desirable is unquestioned. The author has endeavoured to obtain a secure basis for his revision by prolonged observation of the various species, several of which have been raised in cultures from a single example. Variations within the species such as have been frequently assumed and even asserted to occur by some writers were not found, and the author states that most free-living amœbæ can be recognised specifically at least as readily as ciliates or beetles. No special difficulty is met with in classifying about three-fourths of all the known species of Amœbæ, but the remainder are small species the morphology of which has not been studied with sufficient care for the purpose. The supposed shapelessness of Amœbæ has led to previous attempts to classify species wholly with respect to nuclear characters, but the author states that such a systematic basis is no more defensible here than it would be in other protozoa. The genus Protamœba has been defined as lacking nucleus and vacuoles; the author suggests that the enucleate daughters which occasionally arise during fission of an amœba have provided the basis for this genus, the validity of which he therefore doubts, and Gloidium has scarcely a better standing.

Prof. Schaeffer differentiates pseudopodia into determinate and indeterminate. The former grow to a more or less definitely limited size and are then withdrawn; they are generally conical and composed of clear protoplasm only, and they are usually extended only on an advancing part of an amœba. Indeterminate pseudopodia are not restricted as to size; they direct locomotion and may grow large enough to form the entire amœba. They are more or less cylindrical and filled with granular protoplasm.

In putting the question "How many good species of Amœbæ are now known?" the author states that it is not yet possible to give a definite answer. The large, free-living species hitherto described amount to about 85; the parasitic and culturable species are about 70, and with the new species described in the present paper the total number approaches 200. A natural system of classification of the amœbæ must be based on the larger species, and it is with these the author chiefly deals. The changes of form exhibited by an amœba are characteristic and provide the basis for a natural classification. He regards Trimastigamœba, a minute amœba which can take on a flagellate condition, as the most primitive genus.

Prof. Schaeffer describes the different conditions—natural and cultural—under which he has observed his material. He states that no species has yet been found to live and reproduce in both fresh and salt water, though one species can be transferred from sea water to fresh water without apparent injury, and will live about ten days, but reproduction was not observed. More species of amœbæ and more individuals are to be found in tidal pools rich in diatoms than under any other conditions.

The author discusses problems of nomenclature and considers that 'Amœba' must go and be replaced by 'Chaos,' and that the Amœba first called 'der kleine Proteus' (Roesel, 1755) is the same as *Proteus diffluens* Muller and the correct name is *Chaos diffluens*. On submitting this conclusion to about a score of representative American zoologists, the majority expressed their general agreement, but the author wisely remarks that it might be desirable to bring the case before the International Commission for consideration and decision.

The main part of the volume is devoted to careful descriptions of the species, and these are supported by excellent lithographed figures. The memoir forms a most important contribution to the systematic study of Amœbæ.

[1] "Taxonomy of the Amebas, with Descriptions of Thirty-nine new Marine and Freshwater Species." By Asa Arthur Schaeffer. Papers from the Department of Marine Biology of the Carnegie Institution of Washington. 115 pp. 12 plates. Washington, 1926.

Ventilation in Factories.

THE importance of a proper system of heating and ventilation in factories for the comfort and health of the workers need not be emphasised. Considerable difference of opinion as to the correct system probably exists amongst engineers, so that a scientific examination of various common methods should prove of value in selecting that one which the workers find most satisfactory. Dr. H. M. Vernon and T. Bedford[1] have recently made a physiological study of the ventilation and heating in certain factories.

[1] Medical Research Council: Industrial Fatigue Research Board. Report No. 35: A Physiological Study of the Ventilation and Heating in certain Factories. By H. M. Vernon and T. Bedford; assisted by C. G. Warner. Pp. iv+82. (London: H.M. Stationery Office, 1926.) 3s. net.

Continuous records of air velocity and air temperature were taken by means of the hot-wire anemometer and the thermopile respectively. Vane anemometers to determine the directions of the air currents were also used, as well as the katathermometer for direct estimations of the cooling power of the air. The following may be considered the criteria by which a heating and ventilating system should be judged. The room should feel comfortably warm and fresh, yet be without draughts, the temperature at head level should be cooler than that at the level of the feet, and the incidence of sickness and ill-health should be a minimum.

The ideal temperature appears to be about 60° F.-63° F. The cooling power should be 7·0 in winter and about 6·0 in the hot weather, the difference being due to the acclimatisation of the body to the different seasons. These cooling powers can be attained with air velocities of 30 ft. per min. in winter and 50 ft.-100 ft. per min. in summer. The room feels 'too warm' when the temperature rises 4° F. and the cooling power falls one unit, and 'too cold' under the reverse conditions.

An important index of the actual temperature conditions is the temperature gradient from the floor level to the region of the head or higher. It is greatest when the heating system is placed above the heads of the workers: in fact, such a system is roundly condemned as leading to cold feet and hot heads and their accompanying discomforts, and should only be used in conjunction with a heating system at a lower level, when it is desired to avoid down draughts from skylights. The lowest gradient was found when the heating system was placed *under* the floor, and when at floor level it was nearly as satisfactory. The temperature used should not be too high, else the air currents induced become too rapid. It is important that these should be directed upwards, since expired air travels upwards, being lighter than room air, and hence with a down draught there is danger of the workers having to breathe each other's expired air, with the attendant risks of possible infection.

The system of ventilation which gave least draughts and yet most freshness to the air was one of natural ventilation by means of windows, with fan exhaustion in addition if necessary; the outlets for the latter should be situated 7 ft.-8 ft. above the floor. If a plenum system is installed, it should deliver the warm air near the floor from small inlets, and not from inlets situated above the heads of the workers; the latter leads to discomfort and is wasteful of energy. A plenum system delivering *cool* air above head level in conjunction with floor warming gives the most satisfactory type of heating when natural ventilation cannot be utilised.

The efficiency of any given system can be determined from the cooling power and its velocity and temperature components, together with a knowledge of the available window area and the extent to which it is utilised. The latter should be considered relative to the floor area and not to the cubic capacity of the room, since the ventilation is slightly better in a higher room than in a lower one with the same window and floor area.

Evidence is adduced in the report to show that the incidence of sickness is less in workrooms with a good ventilation and a satisfactory mean temperature. The report should, indeed, be studied by all who take part in the designing of modern factories.

International Agreements affecting Port Sanitary Work.

SIR GEORGE BUCHANAN gave a valuable address upon the above subject at the conference of Port Sanitary Authorities during the recent London congress of the Royal Sanitary Institute. He had recently attended on behalf of the British Government the fourth International Sanitary Conference at Paris, at which seventy nations were represented; and he considered that some good results had been achieved. The conference was held with the object of revising and bringing up-to-date the International Sanitary Convention, 1912, under which the various signatory governments agreed upon mutual action and common standards for dealing with the diseases liable to be carried on ships, including cholera, plague, typhus, smallpox, and yellow fever. The conference laid down some new lines of international action which are of great importance to British port sanitary authorities, on whom rests the daily burden of protecting their ports, as well as the rest of the country, from the risks from the importation of these diseases.

The deficiencies of the 1912 International Sanitary Conference have been obvious for many years. To take one example: a ship was only held to be 'infected' with plague when human cases of the disease had occurred during the voyage; but the most dangerous ship of all, with swarms of rats among which plague is prevalent, was not so classified and therefore came under no regulations.

In the new Convention an effort is made to increase the measures whereby countries may obtain all possible intelligence regarding the prevalence of certain infectious diseases. It gives further encouragement to the existing system of interchange of information regarding the incidence of infectious diseases by requiring the signatory governments to reply to any inquiries addressed to them, from the Office Internationale d'Hygiene Publique, for information on any subject affecting the risks of transmission of infectious disease from one country to another. Thus the Office Internationale will discharge the duty of acting as a kind of clearing house for information; and it is authorised to make agreements which will avoid duplication of effort.

In reference to plague, the establishment of new definitions by which a ship with plague-infected rats becomes an 'infected' ship, and a ship with an unusual mortality among rats, a 'suspected' ship, was readily agreed to, as was also the authorisation of measures to prevent rats reaching the shore directly or through merchandise. In ports designated as sufficiently equipped to undertake effective rat destruction, systematic measures will be required to be undertaken once in six months, and a certificate that this has been done, specifying methods and results, will carry the ship on to the next half-yearly period. The inspection officer is authorised to exempt from systematic measures when circumstances permit, and to issue an exemption certificate, which is also valid for six months.

In case of other diseases the measures required by the new Convention have been made to conform to our latest knowledge and experience; and all those applicable to the ship, passengers, and crew have been made strictly reasonable, the aim being to make them more efficacious and, where possible, less burdensome. Seeing how much of the world's immunity from pestilence is due to the measures outlined above, and to the spade work of the port sanitary authorities and their officials, the public has reason to be grateful to the representatives of the seventy nations for the valuable work they have accomplished.

The Measurement of Ocean Currents.[1]

THE application of Bjerknes' circulation theory to the movement of water masses in the oceans has provided a method of increasing utility for the study of ocean currents. If the temperature and salinity of the ocean are given for several known depths at several positions, the difference in velocity of the current at the surface and the various depths can be computed and mapped. It is frequently possible to make observations down to a depth where it may be assumed that no appreciable current exists.

In 1914 a survey in the neighbourhood of the River St. Lawrence was carried out for the Canadian Government by Dr. Johann Hjort and the data obtained were worked up by Prof. Sandström, whose explanation of the theory and its application in hydrography has hitherto been the only work of the kind in the English language. It is not without interest that this neighbourhood is stated to be the first to be charted by a vessel employed solely for that purpose, and that this survey was conducted by Captain Cook immediately previous to his expedition of discovery to the South Seas and the Pacific, which resulted in the addition of Australia to the British Empire.

The U.S. Coast Guard in *Bulletin* No. 14 has published a full account of Bjerknes' theory and the method of its application by Lieut.-Commander E. H. Smith, who is in charge of the scientific work carried out by the Atlantic Ice Patrol, a service inaugurated after the loss of the *Titanic* to warn vessels passing south of Newfoundland of the position of the larger icebergs, of which the Patrol follows the drift. The account is based on a series of lectures by Prof. Helland-Hansen at Bergen, and the examples by which the practical application of the theory is illustrated are taken from observations by the Ice Patrol. It is of particular interest that " the currents calculated from the observational data collected in 1922 off the Grand Banks agree very closely with the drifts of the icebergs of that same year and region." Here the method shows every prospect of being of definite and immediate economic value.

The *Bulletin* contains two handy tables from Hesselberg and Sverdrup's formulæ, to allow for the effect of pressure at different depths upon the specific volume at atmospheric pressure, a correction which becomes necessary where considerable depths are investigated, as in this area. Taking this into account, the method of calculation employed, involving the calculation of the dynamic depth, is in the opinion of the writer not so simple as that employed by Sandström—both methods yielding the same final result.

It is noteworthy that the big German scientific expedition arranged by the late Prof. Merz, which is at present engaged in a very complete investigation of the physical conditions of the South Atlantic, has planned its route in such a way as to make full use of the application of this theory in determining the currents and consequent exchange of the water masses.

It is not unreasonable to hope that this method may provide the means of investigating fluctuations in the north-going current of warm Atlantic water which bathes the western coast of Great Britain and affects our climate and sea fisheries. H. W. H.

[1] " A Practical Method for Determining Ocean Currents," by Edward H. Smith, Lieut.-Commander U.S. Coast Guard. *Coast Guard Bulletin*, No. 14. Washington, 1926.

University and Educational Intelligence.

Cambridge.—Prof. A. C. Seward, in his address on resigning the office of Vice-Chancellor, announced the offer of 150,000 dollars from the Trustees of the Laura Spelman Rockefeller Memorial for the establishment of a chair of political science. The new Vice-Chancellor is the master of Sidney Sussex College, the Rev. G. A. Weekes. The late Disney professor of archæology, Sir William Ridgeway, bequeathed to the University his collections of Stone, Bronze, and Iron Ages, including his series of barbaric currency coins, his collection of barbaric jewellery and of articles of ancient pottery.

J. D. Cockcroft, St. John's College, and J. A. Ratcliff, Sidney Sussex College, have been elected to the Clerk Maxwell Scholarship.

Leeds.—Mr. E. L. E. Wheatcroft has been appointed to the newly created chair of electrical engineering. Mr. Wheatcroft read mathematics and engineering at Cambridge. His practical training was gained in the works of the British Thomson Houston Company and, later, with the General Electric Company in America. He has had an extensive experience in certain phases of heavy electrical engineering (particularly in regard to problems relating to the generation and transmission of power), and has carried out a considerable volume of research work.

In making this appointment the University has in mind the desirability of developing the Department of Electrical Engineering. Compared with some parts of the country, Yorkshire has followed a progressive policy in the distribution of electrical power, and it is felt that this policy should be reflected in the attention paid within the University to the study of the scientific principles of electrical engineering.

Liverpool.—By the will of Mr. Samuel Turner, who died on July 18, the residue of his property is bequeathed to the University " to be applied as the University authorities in their discretion may think fit for the furtherance and advancement of medical research into the diseases of phthisis and cancer, and any kindred diseases." The bequest will apparently amount to approximately 30,000*l.* but will not be available until after the death of Mr. Turner's widow.

London.—The following free public science lectures are announced :—" The Philosophic Significance of Spiritual Values," Prof. G. Dawes Hicks (at University College, October 1) ; " Is Mind governed by Laws ? " Prof. C. Spearman (at University College, October 12) ; " The Motivating of Conduct," P. Hopkins (at University College, November 4) ; " Extreme Cold," Prof. W. H. Keesom (at Imperial College of Science, October 13) ; " The Interaction of Pure Scientific Research and Electrical Engineering Practice," Prof. J. A. Fleming (at Institution of Electrical Engineers, eight, beginning October 20) ; " Some Applications of Modern Science, Prof. E. V. Appleton and others (at King's College, seven, beginning October 7) ; " The Place of Mind in an Organic Theory of Nature," Prof. C. Lloyd Morgan (at King's College, three, beginning October 19) ; " Evil Spirits in Babylonian Religion," C. J. Gadd (at King's College, October 25) ; " Early Arabian Tribes," S. Smith (at King's College, December 10) ; Swiney Lectures on geology, Prof. W. T. Gordon (at King's College, twelve, beginning November 5) ; " The Present position of the Logic of Induction," Dr. C. D. Broad (at King's College, December 1).

Contemporary Birthdays.

October 10, 1871. Earl of Crawford and Balcarres, K.T., F.R.S.
October 10, 1838. Prof. W. Carmichael M'Intosh, F.R.S.
October 10, 1861. Dr. Fridthof Nansen, G.C.V.O.
October 11, 1875. Dr. Arthur William Hill, C.M.G., F.R.S.
October 11, 1864. Sir Henry George Lyons, F.R.S.
October 12, 1868. Prof. John T. Hewitt, F.R.S.

The EARL OF CRAWFORD AND BALCARRES was educated at Eton and Magdalen College, Oxford. Sometime president of the Board of Agriculture and Fisheries, he has been, since 1923, Chancellor of the University of Manchester. Lord Crawford is a trustee of the British Museum, the National Gallery, and National Portrait Gallery.

Prof. W. C. M'INTOSH, emeritus professor of natural history in the University of St. Andrews, is about to celebrate his eighty-eighth birthday. We extend our most cordial congratulations. A fellow of the Linnean Society for sixty-three years, he will, next year, attain jubilee fellowship of the Royal Society. Born at St. Andrews, and educated at its University, his interests have ever centred and been in alliance with those of the ancient northern city. To record his long series of memoirs in zoology would absorb much letterpress. A pioneer of research in fishery problems, he was the first to found a marine biological station in Great Britain. Prof. M'Intosh was awarded a Royal medal of the Royal Society in 1899.

Dr. FRIDTHOF NANSEN, the distinguished Arctic explorer and naturalist, was born at Store Fröen, near Christiania (Oslo), at whose University he was educated, and where, since 1908, he has been professor of oceanography. In 1893 he left in the *Fram* to conduct his famous Arctic expedition. The narrative of this great polar adventure is recorded in "Farthest North" (1897). Dr. Nansen was Minister for Norway, at London, from 1906 until 1908.

Dr. HILL was educated at Marlborough and King's College, Cambridge. University lecturer in botany at Cambridge from 1905 until 1907, he was afterwards, until 1922, assistant-director of the Royal Botanic Gardens, Kew, succeeding then to the directorship on the retirement of Sir David Prain.

Sir H. G. LYONS, Colonel R.E. (retired), is a Londoner. Educated at Wellington College, he passed into the Royal Engineers. Director-General of the Geological Survey of Egypt and allied departments from 1896 until 1909, he has been, since 1920, Director and Secretary of the Science Museum, South Kensington. He is Hon. D.Sc., Oxford and Dublin. A past president of the Royal Meteorological Society, he was awarded its Symons gold medal in 1922 for services to meteorological science, in particular, investigations into the climatology of Egypt and the Sudan. His studies relative to the changes in the level of the Nile and Victoria Nyanza are well known. Sir Henry is chairman of the National Committee for Geodesy and Geophysics (International Research Council).

Prof. HEWITT, emeritus professor of chemistry in the University of London (East London College), was born at Windsor. His studies were conducted at the Royal College of Science, the University of Cambridge, and at Heidelberg.

Official Publications Received.

Transactions and Proceedings of the New Zealand Institute. Vol. 56 (New Series), July 12th. Pp. xxii+860+114 plates. (Wellington, N.Z.: W. A. G. Skinner.)

Wigan and District Mining and Technical College. Calendar, Seventieth Session 1926–1927. Pp. xvi+145. (Wigan.)

The London Schools' Guild of Arts and Crafts. Exhibition at the London Day Training College, Southampton Row, W.C.1, on Wednesday, Thursday, Friday and Saturday, September 22nd to 25th, 1926. Pp. 29+xxiii. (London.) 2*d.*

The North of Scotland College of Agriculture. Calendar, Session 1926–27. Pp. viii+124. (Aberdeen.)

Bernice P. Bishop Museum. Bulletin 24: The Geology of Lanai. By Chester K. Wentworth. Pp. 72+7 plates. Bulletin 25: Revised List of Hawaiian Pteridophyta. By Carl Christensen. Pp. 30. Bulletin 26: Fishes of Hawaii, Johnston Island and Wake Island. By Henry W. Fowler and Stanley C. Ball. (Tanager Expedition Publication No. 2.) Pp. 31. Bulletin 27: Marine Zoology of Tropical Central Pacific. By Charles Howard Edmondson, W. K. Fisher, Hubert Lyman Clark, A. L. Treadwell and Joseph Augustus Cushman. (Tanager Expedition Publication No. 1.) Pp. ii+148+11 plates. Bulletin 28: Report of the Director for 1925. By Herbert E. Gregory. Pp. 42. (Honolulu, Hawaii.)

East Anglian Institute of Agriculture (Essex Agricultural Committee). Calendar, 1926–1927. Pp. 80+xxxii. (Chelmsford.)

Department of Scientific and Industrial Research. The Building Research Station. Pp. iv+10. (London: H.M. Stationery Office.)

The Physical Society of London. Proceedings, Vol. 38, Part 5, August 15. Pp. xix+337-494. (London: Fleetway Press, Ltd.) 6*s.* net.

Medical Research Council. Sixth Annual Report of the Industrial Fatigue Research Board to 31st December 1925 (including Analysis of Published Work). Pp. iv+126. (London: H.M. Stationery Office.) 3*s.* net.

Methods and Problems of Medical Education. (Fifth Series.) Pp. iii + 225. (New York City: The Rockefeller Foundation.)

The Edinburgh and East of Scotland College of Agriculture. Calendar for 1926–1927. Pp. 93. (Edinburgh.)

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, No. 11: Nutrients required for Growth Production with Indian Food-stuffs. By F. J. Warth and Izaz Ahmad. Pp. 211-233. (Calcutta: Government of India Central Publication Branch.) 3 annas; 4*d.*

Journal and Proceedings of the Sydney Technical College Chemical Society for 1923–1924. Edited by the Publications Committee. Vol. 2. Pp. 65 + 7 plates. (Sydney, N.S.W.: Alfred James Kent.)

The Indian Forest Records. Silviculture Series, Vol. 12, Part 9: Notes on Artificial Regeneration in North India. By S. H. Howard. Pp. v + 37 + 10 plates. (Calcutta: Government of India Central Publication Branch.) 1.6 rupees; 2*s.* 4*d.*

Federated Malay States. Annual Report on the Department of Agriculture, S.S. and F.M.S., for the Year 1925. By B. J. Eaton. Pp. ii + 12. (Kuala Lumpur, F.M.S.: Government Press.)

Geofysiske Publikasjoner utgitt av det Norske Videnskaps-Akademi i Oslo. Vol. 4, No. 2: The Eastern North Atlantic. By Bjørn Helland-Hansen and Fridtjof Nansen. Pp. 76 + 71 plates. Oslo: A. W. Broggers Boktrykkeri A/S.) 12 kr.

Birkbeck College (University of London). The Calendar for the Year 1926–27 (104th Session). Pp. 226. (London.)

Journal de la Société des Américanistes de Paris. Nouvelle série, Tome 18. Pp. xxvi + 537. (Paris.)

Annual Report of the Meteorological Committee to the Air Council for the Year ended 31st March 1926. (M.O. 288.) Pp. 74. (London: H.M. Stationery Office.) 2*s.* net.

Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 26: Report of the Irish Radium Committee for the Year 1925. A Review of the Results of Radium Treatment over a Period of Ten Years (1916–1925), by Dr. Maurice R. J. Hayes; Report of One Year's Radium Work carried out in 1925, by Dr. Walter C. Stevenson. Pp. 299-327. (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.) 2*s.* 6*d.*

Journal of the Royal Statistical Society. New Series, Vol. 89, Part 4, July. Pp. x + 635-815 + viii. (London.) 7*s.* 6*d.*

British Museum (Natural History). Picture Postcards. Set D9: Crystals, Series No. 1. 5 cards in colour. 1*s.* Set D10: Crystals, Series No. 2. 5 cards in colour. 1*s.* Set H3: Famous Naturalists, Series No. 2. 1 card in colour, 8 cards in monochrome. 1*s.* (London: British Museum (Natural History).)

Scottish Marine Biological Association. Annual Report 1925–26. Pp. 24. (Glasgow.)

County Council of the West Riding of Yorkshire: Education Committee. Report on the Examination for County Minor Scholarships, 1926. Pp. 31. (Wakefield: County Hall.)

Aeronautical Research Committee: Reports and Memoranda. No. 1006 (Ae. 212): Full-Scale and Model Measurements of Lift and Drag of Bristol Fighter with R.A.F. 32 Wings. By E. F. Anderson, L. E. Caygill and R. McKinnon Wood. (A. 4. a. Full-Scale Work—Aeroplanes General, 127. —T. 2169.) Pp. 5+7 plates. 6*d.* net. No. 1007 (Ae. 213): Full-Scale and Model Measurements of Lift and Drag of Bristol Fighter with Handley Page Slotted Wings. By E. T. Jones and L. E. Caygill. (A. 2. a. Calculations and Model Experiments, 107; A. 2. b. Full-Scale Experiments, 37.—T. 2195.) Pp. 9+14 plates. 9*d.* net. No. 1009 (Ae. 215): Experiments on the Flow behind a Rotating Cylinder in the Water Channel. By E. F. Relf and T. Lavender. (A. 1. b. Photographic Work, etc., 10.—T. 2066 and a.) Pp. 2+6 plates. 9*d.* net. (London: H.M. Stationery Office.)

Sierra Leone. Annual Report of the Survey Department for the Year 1926. Pp. 6+1 map. (Freetown, Sierra Leone: Government Printing Office.)

Madras Fisheries Department. Administration Report for the Year 1924-25. By Dr. B. Sundara Raj. (Report No. 1 of 1926, Madras Fisheries Bulletin, Vol. 20.) Pp. iii+78+7 plates. (Madras: Government Press.) 14 annas.

Official Checklist of the Birds of Australia. Second edition. Compiled by Checklist Committee, Royal Australasian Ornithologists' Union. With Appendix: Scientific Names, Notes and Pronunciation, by H. Wolstenholme. Pp. x+212. (Melbourne: H. J. Green.) 12s. 6d.

Ministerio da Agricultura, Industria e Commercio: Directoria de Meteorologia. Justificação das Normaes de Chuva da Rêde Pluviometrica Brasileira. Por F. E. Magarinos Torres. Pp. 63. (Rio de Janeiro.)

Colony of the Gambia. The Annual Report of the Department of Agriculture for the Year 1925. Pp. 52. (London: The Crown Agents for the Colonies.) 5s.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18, N.S., Nos. 17-28. 17: The Estimation of Organic Matter in Water by Means of Potassium Bichromate and Sulphuric Acid, by Dr. W. E. Adeney and Miss B. B. Dawson; 18: On the Rate of Carbohydrate Transport in the Greater Yam, *Dioscorea alata*, Linn., by Dr. T. G. Mason and C. J. Lewin; 19: The Constitution of Dicyanodiamide, with a Note on the Formation of a Mercury Derivative, by James Bell; 20: On the Rate and Mechanism of the Aeration of Water under Open-air Conditions, by Dr. W. E. Adeney; 21: The Pentosan Theory of Cold-resistance applied to Conifers, by Prof. Joseph Doyle and Phyllis Clinch; 22: The Downy Mildew of Onions (*Peronospora schleideni*), with particular reference to the Hibernation of the Parasite, by Dr. Paul A. Murphy: 23: A Simple Method of Temperature Control for use with Refractometers and Polarimeters, by Michael T. Casey; 24: The Dehydration Rates of Conifer Leaves in relation to Plant Distribution, by Prof. Joseph Doyle and Phyllis Clinch; 25: Photo-electric Measurements of Illumination in relation to Plant Distribution, Part i., by Dr. W. R. G. Atkins and Dr. H. H. Poole; 26: Report of the Irish Radium Committee for the Year 1925; A Review of the Results of Radium Treatment over a Period of Ten Years (1916-1925), by Dr. Maurice R. J. Hayes; Report of One Year's Radium Work carried out in 1925, by Dr. Walter C. Stevenson; 27: Studies on Peat. Part i: The Thermal Decomposition of Peat under reduced Pressure, by Dr. Joseph Reilly and Gerald Pyne; 28: Velocity of Formation of 3·5 Dimethylpyrazole-4-Diazonium Chloride, by Dr. Joseph Reilly and Honorah E. Bastible. Pp. 199-349. (Dublin: Royal Dublin Society; London: Williams and Norgate, Ltd.) 12s.

Rendiconti delle Sessioni della R. Accademia delle Scienze dell' Instituto di Bologna: Classe di Scienze fisiche. Nuova serie, Vol. 29 (1924-25). Pp. 218+xxx. (Bologna.)

Supplement to the Journal of the Indian Mathematical Society, Vol. 16. Report of the Fifth Conference of the Indian Mathematical Society held at Bangalore in April 1926. Pp. xviii+47. (Madras.)

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 8, Memoir No. 4: The Fossil Suidæ of India. By Dr. Guy E. Pilgrim. Pp. iv+65+20 plates. (Calcutta: Government of India Central Publication Branch.) 11.12 rupees; 19s.

Regenwaarnemingen in Nederlandsch-Indië. Zes en veertigste Jaargang 1924. Pp. ii+125. (Weltevreden: Landsdrukkerij.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 70: The Hibiscus Mealy Bug (*Phenacoccus hirsutus*, Green) in Egypt in 1925, with Notes on the Introduction of *Cryptolæmus montrouzieri*, Muls. By W. J. Hall. Pp. iv+15+4 plates. (Cairo: Government Publications Office.) 5 P.T.

Oxford University Press. General Catalogue, 1926. Pp. xii+475+136. (London: Oxford University Press.)

Catalogue 486: Books, Engravings, Drawings, Maps, etc., relating to South and Central America, and the Falkland Islands. Pp. 36. (London: Francis Edwards.)

Classified List of Second-hand Scientific Instruments, No. 88. Pp. vi+58. (London: Charles Baker.)

Catalogue No. 541: Surveying and Drawing Instruments and Appliances. Pp. 230. (London: C. F. Casella and Co. Ltd.)

List No. 169: Cambridge Electrometers and Photo-electric Cells. Pp. 12. (London: Cambridge Instrument Co., Ltd.)

Diary of Societies.

SATURDAY, OCTOBER 9.

BIOCHEMICAL SOCIETY (in Biochemical Laboratory, Cambridge), at 2.45.—Sir F. G. Hopkins: The Purine Enzymes of the Dalmatian Hound.—E. G. Morgan: The Distribution of Xanthine Oxidase.—H. F. Holden and R. Hill: Some Chemical Relationships of Hæmoglobin and its Derivatives.—O. Rosenheim and T. A. Webster: The Non-Specificity of Fearon's Pyrogallol Test for Vitamin A.—M. Perkins and W. Smith: How Bats prepare to Fly.—H. Chick, M. H. Roscoe, and J. L. Leigh-Clare: Distribution of Vitamin D in Nature.—T. Moore and S. G. Willimott: Notes on the Colour Reaction attributed to Vitamin A.—Demonstrations—Dr. J. B. S. Haldane: The Effect of Carbon Monoxide on Animals without Hæmoglobin.—M. Perkins and W. Smith: Respiration of Bats.—H. I. Coombs and T. S. Hele: The Sulphur Metabolism of the Pig.—G. S. Eadie: The Relation between Velocity and Substrate Concentration with Barley Amylase and Starch.—Dr. R. K. Cannan: Echinochrome, the alleged Respiratory Pigment of certain Echinodermata.—P. Eggleton and M. Eggleton: Changes in Phosphates in Frog Muscle as the Result of Activity.

HULL ASSOCIATION OF ENGINEERS (at Municipal Technical College, Hull), at 7.15.—A. Spyer: Water Tube Boilers for Marine and Land Purposes.

MONDAY, OCTOBER 11.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—W. S. Flack: Mental Tests as a Means of Classifying Secondary School Pupils in Mathematics.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—H. Kerr Thomas: The Debt of the Community to the Automobile (Presidential Address).

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—S. E. Flack: Chairman's Address.

CERAMIC SOCIETY (at Central School of Science and Technology, Stoke-on-Trent), at 7.30.—Prof. H. B. Dixon: Ignition of Gases.

INSTITUTE OF BREWING (London Section) (at Engineers' Club, Coventry Street).—W. S. Ward, W. J. Watkins, H. W. Harman, and others: Discussion on The Present Season's Malts.

TUESDAY, OCTOBER 12.

SOCIETY FOR THE STUDY OF INEBRIETY (at Medical Society of London), at 4.—Dr. J. D. Rolleston: Alcoholism in Classical Antiquity.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—A. Beeby Thompson: The Significance of Surface Oil Indications.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—W. G. Burn: Double Acting Oil Engines.

INSTITUTE OF METALS (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—A. Spittle: Chairman's Address.

ROYAL PHOTOGRAPHIC SOCIETY (Kinematograph Group), at 7.—W. Day: The World's Oldest Films.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. J. R. Leeson: Microbes of Disease.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham, Coventry, and Wolverhampton Centre) (at Queen's Hotel, Birmingham), at 8.—H. Kerr Thomas: The Debt of the Community to the Automobile (Presidential Address).

THURSDAY, OCTOBER 14.

INSTITUTION OF AUTOMOBILE ENGINEERS (Derby Graduates' Meeting) (at Derby), at 7.30.—Discussion on Spiral Bevels *v.* Worm Drive for Rear Axles.

INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—A. H. Mundey: Chairman's Address.

INSTITUTION OF MINING AND METALLURGY (at Geological Society).

FRIDAY, OCTOBER 15.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Specimens of Surgical and Anatomical Interest recently added to the Museum.

ROYAL PHOTOGRAPHIC SOCIETY (Pictorial Group), at 7.

INSTITUTE OF METALS (Swansea Local Section) (at Swansea University College,), at 7.15.—Capt. L. Taverner: Chairman's Address.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—R. L. Sarjeant: China from the Engineer's Point of View.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall).—H. J. Young: The Obligation of the Ironfounder to Diesel Engine Users.

SATURDAY, OCTOBER 16.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 3.—W. J. Messer: Conative Control.—R. J. Bartlett: Does the Psychogalvanic Phenomenon indicate Emotion?

PUBLIC LECTURES.

SATURDAY, OCTOBER 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. Robert Aitken: Life in a Red Indian Family.

SUNDAY, OCTOBER 10.

GUILDHOUSE (Eccleston Square, S.W.1), at 3.30.—Dr. Bernard Hollander: Sound and Unsound Mind.

MONDAY, OCTOBER 11.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: The Philosophic Significance of Spiritual Values.

TUESDAY, OCTOBER 12.

UNIVERSITY COLLEGE, at 3.—Prof. E. A. Gardner: Characteristics of Greek Art.—At 5.30.—Prof. C. Spearman: Is Mind Governed by Laws?

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on October 13, 14 and 15.)

WEDNESDAY, OCTOBER 13.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Sir William Willcox: Intestinal Infection in Relation to Personal Health and Disease.

IMPERIAL COLLEGE OF SCIENCE, at 5.—Prof. W. H. Keesom: Extreme Cold.

FULHAM CENTRAL PUBLIC LIBRARY, at 8.—F. H. Edmunds: A Geological History of the London District.

THURSDAY, OCTOBER 14.

FULHAM CENTRAL PUBLIC LIBRARY, at 8.—M. A. Phillips: British Mammals.

SATURDAY, OCTOBER 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. H. M. Dunn: Kashmir, the Country and its People.

SUNDAY, OCTOBER 17.

GUILDHOUSE (Eccleston Square, S.W.1), at 3.30.—Air Vice-Marshal Sir Sefton Brancker: The Scientific Problems of Commercial Aviation.

CONGRESSES.

OCTOBER 13 TO 26.

GERMAN SOCIETY FOR THE STUDY OF DISEASES OF DIGESTION AND METABOLISM (at Berlin).

OCTOBER 25 TO 28.

ITALIAN CONGRESS OF SURGERY (at Padua).