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The Re-challenge to the Ocean.

WE are glad to notice the general approval with which Prof. Herdman's suggestion of a renewed *Challenger* deep-sea expedition has been received, and we hope that men of science will not fail to take immediate advantage of the present very favourable opportunity for urging upon the Government the renewal of the great enterprise of 1872. Never, unhappily, had the population of these islands to think so much and so anxiously of maritime affairs as during the four years that began in August, 1914. We believe that this concern did not die away when peace was arranged, and we may be sure that very many people are now interested, not only in the further development of our mercantile marine and deep-sea fisheries, but also in the exploration of the ocean as a matter of pure scientific research.

It was, therefore, very fortunate that this was the subject of the Presidential Address at Cardiff, and that the latter succeeded in arousing public interest in a remarkable manner. Politically, also, the time is opportune. Never has the naval supremacy of this country been so unquestioned as it is at the present time, and for this we have to thank the high level of character and resource that has been exhibited by all grades of seagoing men, not only professional sailors but also fishermen and yachts-men. These qualities must be our best defence in the unforeseeable dangers that may yet threaten us as a nation, and we can think of no better way of cultivating them than by endeavouring to arouse a general interest in everything connected with the sea. Here, then, we have a way, by giving the people the opportunity of following with interest the progress of a great national voyage of deep-sea exploration.

Thus, both from the point of view of national security and that of the development of our marine resources, much is to be said in favour of a renewed *Challenger* expedition, but here our predominant interest ought to be that of pure scientific investigation. It is fifty years since the original proposal for a national oceanographical voyage of exploration was made, and at that time the difficulties of fitting out a ship for that purpose were much greater than they are now: thus, the officers of the *Challenger* hesitated for a long time as to whether they ought to use the recently adopted steel wire for sounding and dredging in preference to hempen rope, and finally they decided upon the latter. In almost every respect the details of oceanographic methods have been improved almost out of recognition. It took several hours then to make a deep sounding, and a whole day to work a dredge for an hour or so in very deep water, and then the results were often uncertain. Now these operations can be carried out expeditiously, and with every prospect of complete success, so greatly have the cable ships improved sounding apparatus and the steam trawlers fishing gear. Plankton methods have been so intensively studied during the last twenty years that it should now be possible to arrange a programme that may solve many theoretical questions with the indispensable economy of labour. Physical and chemical methods for the determination of temperature, density, and other sea-water variables have been developed to a remarkable degree by the international organisation for fishery investigations.

There may possibly be suggestions for new methods of research in the study of the artifices adopted in anti-submarine warfare. We may be certain that with the perfected apparatus now at the disposal of an ocean-going marine-biological and hydrographic expedition results may be obtained much more quickly and accurately than in 1872. It is true that various deep-sea expeditions have been made since the time of the *Challenger*, and that the new methods have been employed. Still, those expeditions were mostly rather small ones, and what is wanted now is a voyage of, at the very least, the duration and scope of that of the *Challenger*. It is also true that all the recent expeditions have been foreign, and that Great Britain has, ever since 1872, lagged behind in this respect. It is owing to our present condition of naval superiority and commercial progress that we should do our share in oceanographical research.

In many ways the outlook is now markedly different from what it was in 1872, and so much more evident is the need for renewed investigation. The detailed study of the results obtained by the *Challenger* herself, and the discussion which these have now received, point to the need for renewed investigation, both on more intensive and more extensive scales. It cannot be said that the recent expeditions afford data for the settlement of most questions. One must never forget what a very insignificant fraction of the whole area of the ocean bottom has been touched by *all* the deep-sea expeditions. There is an enormous tract, said Mr. Tate Regan at the British Association discussion, lying round the Falkland Islands and up as far as Montevideo, which is almost unknown. All this lies within the 100-fathom contour line, and it may be the region of lucrative fisheries. Yet over it all there are only some eight trawling records—two by the *Challenger* and six by the *Albatross*. In these days, when trawler-owners are seeking new grounds, when the British fishery industry looks like being world-wide in its scope, and when steam fishing-vessels can cross the ocean and can fish commercially at depths of 100 to 200 fathoms, such a suggestion cannot be ignored.

All such investigations carried out with the object of discovering fishing-grounds, charting unknown sea-bottoms, or investigating tides and currents from the point of view of the navigator are, of course, utilitarian. But they employ scientific methods and they obtain a great surplus of data to be worked out from a purely scientific point of view. We have not the space here to advert to the enormous importance and theoretical interest of a study of the ocean from the point of view of meteorology. Nor can we insist, as we ought to do, on the reflex value of an arousal of popular interest in marine science. Immersed, as we are at present, in the problems of commerce and industrial production, one is apt to forget how curious are all people connected with the sea in the results of marine research. That popular curiosity and interest is something that scientific organisation ought legitimately to attempt to satisfy.

Philosophical Aspects of Nature.

(1) *The Concept of Nature: Tarner Lectures delivered in Trinity College, November*, 1919. By Prof. A. N. Whitehead. Pp. ix+202. (Cambridge: At the University Press, 1920.) Price 14*s*. net.

(2) *Lectures on Modern Idealism*. By Josiah Royce. Pp. xii+266. (New Haven: Yale University Press; London: Humphrey Milford; Oxford University Press, 1919.) Price 12*s*. 6*d*. net.

IT may seem that in bringing together two such widely divergent views and methods as those represented by the present professor of pure mathematics in the Imperial College of Science and Technology, and by the late genial and kindly Harvard professor and leader of modern idealism, the problem with which each of these courses of lectures deals is in danger of being prejudged. Prof. Whitehead's method is severely practical, that of Royce speculative and theoretical. It is, however, in contrasts that the profounder meaning of antithetical theories is revealed. These two courses of lectures—very similar in form and in aim—separated in time by an interval of thirteen years, both deal with the same subject, the concept of Nature, and both are conscious, despite a fundamental divergence, of an identical problem.

(1) The Tarner Lectures of Prof. Whitehead consist of a core of constructive work. Certain kinds of entities are posited for knowledge in sense-awareness. The classification of these, and the investigation of the sorts of relations they can have to one another, form the constructive work undertaken. The most fundamental of these entities are events, and the first kind of relation examined is time. The factors in Nature represented by the conception of space are next brought under review, and the method by which they are analysed is named "extensive abstraction." Space and motion are then considered, and lead to the formulation of a theory of congruence—that is, of measurement in space and time. This plunges us into the relativity controversy, and enables the author to define his position in regard to the theory of Einstein. Finally, we have a theory of "objects," which are described as "the elements in Nature which do not pass." Objects are "recognised," events happen; an event occurs once and is unique, but objects have the character that they can "be again." This core of constructive work has a prologue and an epilogue in the two introductory and the two concluding chapters. It is in these that the problem underlying the concept of Nature is acknowledged, the principle which must rule scientific inquiry discussed, and the issue between the divergent

methods, the *a priori* and the experimental, decided.

Prof. Whitehead sees very clearly and expresses very boldly the philosophical problem of Nature. It is admirably expounded in his chapter on "Theories of the Bifurcation of Nature." By bifurcation he means that Nature is presented first in sense-awareness and then in a conceptual activity of thought. Though the two consequent forms, sense-images and concepts, are inseparable, they are so absolutely distinct that when we reflect on them they present themselves as two totally different kinds, or orders, of facts, between which the relation, so far from being obvious and transparent, is literally incomprehensible. For not only is our sense-awareness fragmentary, requiring an activity of conception to complete it—as when, for example, we conceive another side of the moon—but also the fragmentary appearances themselves are referred to another kind of reality, conceived as existing in itself and called Nature. Physical science treats of electrons, æther waves, and such like, as existent entities, sense-awareness being a special form of the relation of these to the mind. This old philosophical problem has recently forced itself on the attention of physicists by reason of the startling nature of Einstein's special and general relativity principle. In fact, Einstein may truly be said, adapting the famous phrase of Kant, to have roused physicists from their dogmatic slumber. Prof. Whitehead treads the new ground confidently, but yet with caution. He will not have the "curvature of space," and he insists that the concept of Nature shall concern the reality of the observation, unconfused with any question concerning its relation to the observer and his system. To deny the possibility of this detachment is in his view not simple scientific scepticism, but destruction of the basis on which any physical science can be constructed.

(2) The lectures of the late Prof. Royce, originally entitled "Aspects of Post-Kantian Idealism," were first delivered in 1906, and therefore antecede the apparition of the Principle of Relativity. This is not very important, because that principle propounded nothing in the least strange and unfamiliar to philosophers. It is, indeed, essentially one and identical with the principle of idealism. It is its confirmation by experiments which has brought it home with such force to the scientific worker. Although, therefore, the lectures are largely historical, and deal with a philosophical movement and speculation a century old, they are vitally relevant to our present problem. The problem of post-Kantian idealism was essentially the problem of Nature, in particular the fact that while Nature is a concept brought to birth by the mind itself in its intellectual activity, under the stimulus and out of the material provided for it by sense-awareness, yet this concept stands before the mind as necessarily independent and alien in its existence, and as the ground of the existence of the mind itself.

It is curious how, in the historical retrospect of the important philosophical movement which followed Kant, Hegel overshadows all his contemporaries. One of the most interesting portions of this book is the account of the wonderfully brilliant work of Schelling, especially in his early period. No physicist has grappled the problem of Nature with greater zeal or with keener insight than this philosopher.

It is not our purpose to pass judgment, but we commend these two books—both remarkable for their lucidity and intellectual honesty—to all who wish to have a comprehensive grasp of the physical and metaphysical problem of the concept of Nature.

H. WILDON CARR.

The Vehicles of Hereditary Qualities.

The Physical Basis of Heredity. By Prof. T. H. Morgan. (Monographs on Experimental Biology.) Pp. 305. (Philadelphia and London: J. B. Lippincott Co., 1919.) Price 10*s.* 6*d.* net.

SO far as the study of heredity means formulating and explaining the resemblances and differences between successive generations great progress has certainly been made, and Prof. Morgan thinks it is mock modesty to refrain from saying that many problems have been solved. The present book is a masterly account of recent work on the physical basis of inheritance, which means, for practical purposes, the chromosomes of the germ-cells. The general evidence in support of the chromosomal theory is once more discussed; its fundamental propositions are clearly stated and abundantly illustrated; and numerous recent subtleties, at varying levels of probability, are explained. The book is indispensable to serious students of biology.

The first general principle is Mendel's law of segregation. The fertilised ovum contains paired factors or genes, causally linked with certain characters; these come into relation to each other, but separate off cleanly in the germ-cells of the offspring, one member of each pair going to one daughter-cell, the other member to the other cell. It is during maturation that the conjugation of homologous (paternal and maternal) chromosomes occurs and is followed by their subsequent segregation. In all probability, apart from hybrids altogether, the germ-plasm of each immature germ-cell is made up of pairs of elements or genes which segregate during maturation. In recent years an entirely unexpected and important discovery has been made in regard to segregating pairs of genes (allelomorphs). In an ever-increasing number of cases it has been found that there may be more than two distinct characters that act as allelomorphs to each other. For example, in mice, yellow, sable, black, white-bellied grey, and grey-bellied grey are allelomorphs—*i.e.* any two may be present (as a pair) in an individual, but never more than two. It may be noted, too, that at an early stage in his argument the author rejects the criticism that Mendelian characters are necessarily superficial characters. He also points out what critics of Mendelism sometimes fail to understand, that species differ from one another, not by a single Mendelian difference, but by many.

Mendel's second law describes the free and independent assortment of the genes. If an immature germ-cell contains the factors or genes—"tall," "short," "colour," "white"—then at maturation the genes "tall" and "colour" (*sit venia verbis*) will go to one daughter-cell, "short" and "white" to the other, or "short" and "colour" to one, and "tall" and "white" to the other. Now the cytological evidence is that each pair of chromosomes, just before the reduction division, consists of a maternal and a paternal member, and there is a free or random assortment of some maternal chromosomes to one pole and some to the other, and similarly for the paternal chromosomes.

But further investigation is disclosing an increasing number of cases in which free assortment does *not* occur. Many characters have been found to keep together in blocks in successive generations instead of assorting freely. This is what is called *Linkage,* one of the post-Mendelian elaborations.

Correlated with the idea of linkage is that of *Crossing Over,* which means an interchange of blocks of genes between homologous pairs of chromosomes. It may be frequent or rare; it may occur in the germ-cells of one sex, but not in those of the other; the size of the blocks may vary at different temperatures and for internal reasons; and a break in one region of the chromosome may interfere with a break in another region. It is altogether very curious and intricate. The genes of a pair do not jump out of one chromosome into the other, so to speak, but are changed by the thread breaking as a piece in front of them or else behind them, but not in both places at once. It is possible that there is a limiting value for crossing over, and if this can be established it may lead to the discovery of the lower limit of the size of the gene. It seems that the crossing over may be effected at the time of the conjugation.

The data in regard to linkage and crossing over lead to the conclusion that the genes are arranged in linear order, standing at definite levels in the chromosomes and definitely spaced. Another interesting suggestion is that the correspondence seen in *Drosophila melanogaster* between the number of linkage groups and the number of chromosomes may hold good generally. Yet another suggestion is to be found in the curious fact, too frequently illustrated to be a coincidence, that one species may have twice as many chromosomes as a closely related one.

In regard to the view that the difference between the sexes is connected with the distribution of particular chromosomes, Prof. Morgan discusses two opposing interpretations. In certain species a female organism develops from a fertilised ovum with two X-chromosomes, while a male organism develops from a fertilised ovum with only one X-chromosome, with or without a Y-chromosome in addition. The question is whether the presence of the two X-chromosomes causes a female to develop, or whether XX is merely an index of sex. According to the author the evidence is now conclusive that sex follows the chromosomes, not the other way round. He shows ingeniously how the chromosome theory of sex may be applied to the interpretation of inter-sexes, gynandromorphs, and allied phenomena.

The conception of a gene or factor seems to become increasingly complex. A gene is to be thought of as a certain amount of material in the chromosome that may separate from the chromosome in which it lies, and be replaced by a corresponding part (and none other) of the homologous chromosome. But it is now becoming clear that a gene is causally associated with *manifold* effects; that different genes may produce characters that are indistinguishable, such as whiteness in poultry; that each character is the product of many genes, and so on. Moreover, the variability of a character is not necessarily due to variability in the gene; much may be due to variability in the environmental conditions of development. Critics of Mendelism must read this book, not necessarily to criticise less, but to criticise more wisely.

There are so many illuminating discussions in Prof. Morgan's book that we find it difficult to stop. Regarding mutations it is pointed out that they are of infrequent occurrence, that the change is definite from the beginning, that some at least are recurrent, and that the difference between the old character and the new is small in some cases and greater in others. But their origin remains obscure. As to their supposed "chance" character, it is pointed out, very usefully we think, that the degree of development of any character increases the probability of further stages in the same direction. Species are to be thought of as groups of genes, and related species have a good many genes in common. Thus similar mutations are likely to occur in different but related species. Of this, indeed, studies on Drosophila have furnished experimental evidence.

We do not know how many books on heredity Prof. T. H. Morgan has written. Their succession marks the rapid advance of a department of science to which his personal investigations have made very important contributions.

New County Histories.

The Victoria History of the Counties of England: Hampshire and the Isle of Wight. Part i., pp. 46+2 maps. Part xv., pp. 409–470+1 plate: *Buckingham.* Parts iv. and vi., pp. 177–205+map and plate. Part xxiii., pp. 312–372+5 plates: *Hertford.* Parts ii. and iii., pp. 43–221+map: *Berkshire.* Part ii., pp. 27–68+map. Part iv., pp. 173–196+map and 12 plates: *Surrey.* Parts i.–iv., pp. 254+4 maps and 2 plates. (London: Constable and Co., Ltd., 1920.) Prices various.

"THE Victoria History," finely conceived and excellent in performance, at the outset in 1900 largely disdained plebeian methods of advertisement. Wealthy country gentlemen were often left in ignorance of its existence, and slender purses were mocked by the high cost to be pledged for the history of any single county. A more considerate policy has now been adopted. Essays by eminent specialists can be purchased separately. Comparison with earlier county histories shows a surprising advance in recognising the importance of natural knowledge.

Since Nature makes merry with man's artificial boundaries, a work taking all our English counties in detail cannot avoid some overlapping and repetition in dealing, for example, with botany and butterflies, with mice and their alliterative contrast, men. The difficulty is enhanced in zoology by the hordes of insects. Records stating when, where, and by whom each species was captured in a particular county become rather appalling. It is a relief to read in the "History of Surrey" that out of 3000 British flies (Diptera) only a miserable tale of 360 can be credited to the county. Yet this luck is "solely due to the paucity of collectors of this order of insects" (p. 151). Though Diptera be few, "the Phytophagous hymenoptera, *i.e.* saw-flies, wood-wasps, and gall-flies, are abundant throughout Surrey." Avoid, however, speaking disrespectfully of saw-flies. "Saw-flies can easily be bred and reared in captivity, and it is only by doing this in large numbers that we can hope to arrive at the laws which control that most mysterious phenomenon, parthenogenesis." Mr. Chawner further declares that a common species, *Poecilosoma puteolum,* produces females only, arguing from the experience that several thousands have been bred for six years in succession, and all turned out to be of that sex (p. 91). Still, it is hard to prove a negative, even for broods to which Sir Ray Lankester's term "impaternate or fatherless" would seem appropriate.

The botanists agree that "the best division of a country for botanical purposes is into river-basins" ("Hertfordshire," Hopkinson, p. 48); to explain the distribution of the flora of Berkshire, "various botanical districts essentially based on the river drainage" are used by Mr. Druce (pp. 29, 51); so also for Surrey Mr. Beeby accepts the division into districts founded on the river-basins "as the most desirable in all respects," with exceptions. The grand exception is, as he explains, that "the geological strata run in such remarkably parallel bands from east to west, while the streams run transversely to them, so that each of the principal rivers has its share of each of the formations." For Surrey Mr. Lamplugh says, "the geological structure of the county is so simple, and its existing features depend so closely upon this structure, that it forms an ideal tract for the study of the elementary principles of the science." The same might be said of the geology of Hampshire as displayed in the late Mr. Clement Reid's luminous treatise. The map of Surrey shows how you may "walk east and west upon the same formation along the line of 'strike' from one end of the county to the other; while if we go southward we soon cross to underlying, and if northward, to overlying beds."

Space permits only bare notice of an important historical disquisition on "Forestry and the New Forest," by Nisbet and Lascelles; and of the profusely illustrated essays on Early and Anglo-Saxon Man in Berks and Bucks by Shrubsole, Clinch, and Reginald Smith; while no attempt can be made to discuss the interesting local history of the "Aylesbury Hundred" of the latter county. In the botany of Surrey the late George Massee leaves a curious note of chronology by saying (p. 65): "The edible boletus (*Boletus edulis*) has a cap corresponding in size and colour to a penny bun." When will the penny bun once more rival the cap of a boletus?

Practical Organic Chemistry.

The Preparation of Organic Compounds. By E. de Barry Barnett. Second edition. Pp. xv+273. (London: J. and A. Churchill, 1920.) Price 10*s.* 6*d.* net.

THE work which the universities were invited to undertake in preparing synthetic drugs and "poison gases" in more than usual laboratory quantities forced them to replace their costly glass and porcelain apparatus, wherever possible, by larger and stronger vessels of tinned iron and by earthenware basins of cheap material. This experience has been wisely turned to account in the new edition of Mr. Barnett's book, in which a description of such apparatus is given. Although it is desirable for the beginner to use transparent vessels, in which reactions can be easily watched and controlled, and to manipulate quantities which do not demand too great an expenditure of time, the knowledge of how to apply larger scale methods he may later be called upon to adopt will prove invaluable. Moreover, the habit of discarding, as occasion demands, the usual laboratory vessels in favour of less elegant but more serviceable utensils is a good mental and moral exercise. With the exception of the above-mentioned description and the addition of a few new preparations, no fundamental change has been made in the size and scope of the new edition. It takes the form made familiar by Gattermann's and Freundler's well-known treatises, and by many other books dealing with this subject.

Which of the two systems is the more satisfactory, namely, discussing general methods and apparatus first, and then referring to them in the later preparations, or allowing the student to familiarise himself with them by actual examples involving their use, must be left to the individual teacher to decide. He must also determine what amount of detail he thinks it desirable to supply in his account of the preparations. There is no doubt that some simple modification in the conduct of a reaction which additional details would supply will often convert failure into success, with a corresponding economy in the student's time. On the other hand, advantage may be gained by the student having to surmount his own difficulties.

There is, on the whole, not much to choose between the two methods. The present writer is inclined to think that, as the purpose of the practical work is mainly to assist the student in developing his general knowledge of organic chemistry, the greater the variety of reactions he can perform during his course, which is often not too long, the more he will profit by it. Later research will afford ample opportunity for the exercise of his ingenuity in meeting and overcoming difficulties.

J. B. C.

Our Bookshelf.

The Essentials of Histology: Descriptive and Practical. For the Use of Students. By Sir E. Sharpey Schafer. Eleventh edition. Pp. xii+577. (London: Longmans, Green, and Co., 1920.) Price 14*s.* net.

"THE Essentials of Histology" preserves, in its eleventh edition, the well-known characteristics of the previous editions of this standard work. The volume is growing in size, but the additions are mainly of new illustrations. These are uniformly good, and conform to the general tendency of successive editions to present photographic representations of actual preparations, as well as semi-diagrammatic drawings emphasising points which the artist deems of special import. The latter are of great service to the beginner, but carefully selected photographs mean more to the advanced student. Both varieties are utilised in the "Essentials," and monotony in the figures is avoided by a pleasing use of colour. Although mainly a descriptive work, the practical side is better represented than a cursory glance would reveal, and the directions briefly given at the head of each lesson are amply sufficient, if exactly followed, to enable the student to obtain the preparations desired. Further practical directions are given in the appendix, which is a synopsis of general and special histological methods.

A Naturalist on the Amazons. By H. W. Bates. Abridged and edited for schools by Dr. F. A. Bruton. (English Literature for Secondary Schools.) Pp. xix+182. (London: Macmillan and Co., Ltd., 1920.) Price 2*s.* 6*d.*

IN this abridged edition selections from Bates's original work have been chosen which deal mainly with the natural history of the forests of the Amazon. A short account of the more remarkable forest trees is included, but the bulk of the book consists of selections describing the fauna of the country. Illustrations from photographs are given of most of the animals mentioned. Dr. Bruton contributes an interesting introduction and some helpful notes. We are glad that Bates's vivid descriptions of Nature and man are made available for appreciation by young people in schools by the issue of this abridged edition of his masterpiece.

The Advancement of Science: 1920. Addresses delivered at the 88th Annual Meeting of the British Association for the Advancement of Science. Cardiff, August, 1920. (London: John Murray, n.d.) Price 6*s*. net.

IN this volume are published the presidential addresses delivered at the recent meeting of the British Association at Cardiff. Such a collection, representing, as it does, the views of the leading authorities on progress made in various departments, and discussing some problems of prime interest, will be welcome to all students of science as well as to many members of the educated public. We hope the demand for the volume will justify the attempt of the Association to secure a wider circle of readers for the most interesting contributions to its annual meeting.

A Handbook of Physics and Chemistry. By H. E. Corbin and A. M. Stewart. Fifth edition. Pp. viii+496. (London: J. and A. Churchill, 1920.) Price 15*s*. net.

THE requirements of the new syllabus for the First Examination in physics and chemistry of the Conjoint Board of the Royal Colleges of Physicians and Surgeons have made it necessary to double the size of the volume issued in 1899. Short articles on statics, hydrostatics, expansion, refraction, absorption spectra, current electricity, ionisation, and radio-activity have been added in order to meet the new syllabus, and much new matter has been inserted with the view of making the book more useful to students preparing for other elementary examinations in physics and chemistry.

Common Diatoms. By Thos. K. Mellor. Pp. 16 +plates. (London: William Wesley and Son, 1920.) Price 6*s*. net.

THIS little pamphlet consists of eight pages of introduction, followed by a general index and seven plates of diatoms. The author's intention is to illustrate such diatoms as are usually found on "circle" slides sold by opticians, from such districts as England, Japan, Hungary, New Zealand, Istria, Samoa, the Adriatic Sea, Maryland, etc. The seven plates contain about 400 figures, and are fairly well drawn.

The introductory remarks are of a popular description, and do not profess to deal with diatoms from a scientific point of view.

Problems in Physical Chemistry: With Practical Applications. By Dr. Edmund B. R. Prideaux. Second edition, revised. Pp. xii+294. (London: Constable and Co., Ltd., 1920.) Price 18*s*. net.

DR. PRIDEAUX's book, in its first edition, was found useful by teachers and students of physical chemistry, and served a very important purpose by assisting in directing the teaching of the subject into practical and intelligible channels. The new edition has been carefully revised and improved in many respects. The high price of the book, which is somewhat poorly bound and printed on not very good paper, will be the main drawback to its popularity among students.

Letters to the Editor.

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

The British Association.

THE Cardiff meeting of the British Association was pleasant and profitable in various ways, but the membership in an important and prosperous city like Cardiff might have been larger, and a certain amount of apathy on the part of the public in general to the presence of the Association was noticed. The Press did its best, but perhaps an influx of material prosperity has rendered folk temporarily callous to other forms of activity. My recollection of the Cardiff meeting in 1891 is that it excited more local interest—perhaps because it was the first in the city; perhaps also because the meeting included the week-end, extending from Wednesday to Wednesday, instead of ruthlessly encroaching on the four chief working days of the week and beginning sectional operations ten hours before the president's opening address. It is understood that future meetings will return to pre-war conditions in this and other respects. Other improvements may be desirable, so the manifesto of your Cardiff correspondent, Dr. R. V. Stanford, on p. 13 of NATURE of September 2 is opportune and timely.

The British Association differs from other learned societies in that it does address the general public, and travels from place to place in order to reach a wide constituency. In so far, therefore, as it takes the easier course and caters merely for specialists, it is not fully executing its mission. Its function might be described as bringing the general public into personal contact with a scientific discoverer and giving them some inkling of his methods and results. Technicalities are not always inappropriate, so they be suitably expounded; for no one can suppose that scientific work is a simple and easy matter readily understanded of the people.

If the public were treated to nothing but the superficial froth they would rightly feel defrauded; they wish to realise that a plenitude of coherent material lies beneath the surface, much of it necessarily rather deep. The enthusiasm of a scientific worker is, or should be, contagious; and an impression of real value and interest can be produced, in spite of a plentiful lack of understanding.

Moreover, though it is difficult to overestimate the ignorance of the bulk of the population, there are likely to be in every civic community a few young minds, instinctively eager and unconsciously able, who may be stimulated by a discourse from a great man and become themselves disciples, and ultimately even co-workers. The awakening of one such youth per meeting would be well worth while; nor is it too much to expect. No one can tell beforehand what particular seed will come to fruition, and instances of such awakening in the past are historic. What is called science-teaching at schools has been known before now to have a depressing effect; direct aiming at a result may not achieve it; unorganised and indirect impersonal instruction, coupled with unconscious personal influence, may occasionally be far more stimulating.

To come to details, avoiding every sort of contemporary allusion and speaking quite generally:

The President's Address should, as a rule, deal with some comprehensive and enlightening theme; but the president is an individual liable to be overweighted by the opportunity for a responsible, more or less ponderous, utterance, and it is useless to legislate for an individual.

The function of the two evening lectures is fairly understood, and great trouble is sometimes taken over their illustration. They can be approximately on the lines of a Friday evening discourse at the Royal Institution, but should be still more popular, because the audience, for the most part, will not be so experienced and specifically cultivated. They should not, of course, be of the mere elementary "popular lecture" type, and the manner of presentation should be such as to arouse admiration even in those specialists who are learned in the particular subject treated of. But whereas at the Royal Institution it is customary to hear a man discourse on his own investigations, no such tradition naturally exists at the British Association; the work of a foreigner or of a recluse may be described, or any other topic dealt with which either is in the public mind already or may be conveniently introduced there. These lectures are also an opportunity for interesting not only the general public, but also the working members of the Association belonging to other sections, who are glad of an opportunity of hearing something authoritatively and well expounded by an expert in some branch of science other than their own.

If examples are permissible, Clerk Maxwell's discourse on "Molecules" in 1873 at Bradford was not only profoundly, absorbingly, interesting at the time of delivery, but was a genuine elucidation of the molecular problems of that day and of the kinetic theory of gases; and Huxley's discourse on "Animal Automatism," the year afterwards at Belfast, was a marvel of eloquence free from adventitious aids or accessories of any kind.

So far agreement may be expected; difficulties begin when we contemplate the work of the sections. Here a certain amount of specialisation is inevitable, and the public who attend the sections expect, and on the whole enjoy, proceedings rather out of their depth. Yet still there are ways of interesting experts without being wholy unintelligible to everyone else. Dullness, indistinctness, inaudibility, and the absence of clarity, are not appreciated even by experts, though much may be forgiven when the matter is new or important. But liveliness and suggestiveness are specially appropriate at sectional meetings, attended as they are by kindly hosts who are anxious to get some glimmering of what science "feels like" to those engaged in it, whom they are for the nonce entertaining. It is probably unwise to limit the proceedings to the delivery of set papers according to a prearranged and rigid programme.

Of late years there has been a tendency to curb and curtail discussions for the sake of completing each item of a programme so far as possible to time. But in the old days discussions were often the most lively, and sometimes the most instructive and suggestive, part of the meeting. Kelvin and Stokes, Maxwell and Rayleigh, FitzGerald and Larmor—these were men worth hearing; and, whether they happened to contribute papers or not, their presence was stimulating and their remarks encouraging to the younger men. It was at one of these meetings long ago that the then unknown J. P. Joule was "discovered," and many another young man was brought into notice by the enthusiasm of Sir William Thomson and the giants of his era. Then again, Cayley and Sylvester, H. J. S. Smith, W. K. Clifford, and one or two still living, shone brilliantly in pure mathematics; and there were the Astronomers as well. Blackboards full of equations were far more frequent than the dim and depressing atmosphere required for lantern-slides, and the audience found this manner of exposition exhilarating in its own peculiar way. To see physical results emerging from chalk and duster is always an astonishing and edifying spectacle. The realities of physical investigation, and their obviously recondite character, contribute to respect. Brilliant mathematical exposition is both cheaper and easier, in a peripatetic society, than brilliant experimenting; and if both are forbidden, the true atmosphere of science is not represented. Diagrams are more trouble than lantern-slides, but are in many respects better.

I see I am speaking of the *personnel* of Section A only—it is inevitable—but I suppose that something of the same sort must have been occurring in other of the older sections; certainly a large *clientèle* assembled whenever Huxley was expected to speak, and sometimes he was quite reasonably technical in substance as well as literary in form. Are we to conclude that there were giants in those days, and despair of maintaining the standard? There is splendid work being done now, but the conditions somehow seem less attractive.

Let me be not misunderstood as making any complaint! The proceedings in Section A were brilliant this year, from the president's address downwards, and one came away full of admiration for the work of the present generation; but the programme was rather too full. So it used to be long ago also, though four hours were then given to it instead of three, and no kind of time-table was attempted. When Sir William Thomson got into his stride few presidents had the hardihood to check him or to curtail his sometimes rambling eloquence; while his young disciples were conscious of enthusiasm and enlightenment, commingled with occasional boredom, and the audience was often delighted with his vivacity, however little they were able to follow.

I feel sure that among the younger men now there are some whose more frequent contributions to a discussion would be most welcome, but the incubus of a set programme and limited time, together with apparently an over-modest expectation of hypercriticism from their immediate fellows, seems to restrain them. The secretaries of Sections used not to limit their activities to providing for the revelations of others; they shed a light of their own. No self-denying ordinance was inflicted on the president, the vice-presidents sat on the platform, and when a lively discussion seemed to be beginning the exigencies of the programme were ignored. The discussions I speak of were not formally arranged; they arose spontaneously. I remember, for instance, a lively passage-of-arms between Herbert Spencer and Clerk Maxwell on a thermodynamical subject. Sometimes there were real controversies, and occasionally some dissipation of energy in the form of heat. The modern prearranged discussions are an innovation—possibly a good one—but in organising such a discussion it has turned out to be a mistake to fire off a group of more or less allied papers by way of an opening. Disconnected and separately conceived papers do not really open; they are apt to dissipate interest and stop real discussion, partly by too extended a range, partly by consumption of time.

The procedure of a "debate," one proposer and one opposer, followed by spontaneous and unprepared speeches which really deal with the points raised, would seem a not impossible ideal.

It must be admitted that the more elastic and semi-random procedure of old days sometimes entailed disappointment, especially among the butterfly visitors who flitted from section to section trying to be present wherever a well-known speaker was on his feet. A rather futile proceeding it usually was, and yet there was merit in it from the missionary point of view. But the butterflies must take their chance; it is the more steady and persevering insects for whom we should aim at providing honey.

How to do it I confess I know not with any certainty; yet it must be known beforehand, in a general way, that one or two subjects will in all probability prove attractive, and it is a pity when, through lack of collaboration between the sections, a number of such attractions compete for attention on a single day.

The General Secretaries have striven this year to unite the office-bearers of the different sections, and generally to carry forward or renew the old traditions so far as possible. It may be hoped that their efforts will have a good effect in the future.

OLIVER J. LODGE.

Normanton, Lake, Salisbury, September 10.

P.S.—Since writing the above I have seen your leading article in NATURE of September 16. I perceive that you hold views similar in many respects to my own, and I anticipate that many readers of NATURE will be in agreement, now that you have given them an opportunity of reconnoitring the whole position. O. J. L.

September 17.

ALLOW me to express my concurrence in the view presented in the leading article in NATURE of September 16 as to the necessity for a re-organisation—a re-adjustment to the needs of the day—of the British Association for the Advancement of Science. The Association has been allowed to develop and grow in various directions without sufficient control or consideration as to how it may best serve the purpose for which it exists. It was at first a society of a missionary character, aiming at spreading in the dark regions of these islands a knowledge of and interest in science. Soon it added to this purpose that of an annual picnic and friendly gathering of workers in science. Then followed the gathering of funds by fees for membership; the application of those funds to pay, here and there, for research. Later ensued an extended and overwhelming creation of "sections," so as to give all sorts of people a meeting ground for discussion and, incidentally, for self-advertisement. The result of the last step was an embarrassing demand for meeting-rooms and committee-rooms to be provided by the town which had invited the Association to give it a visit. At the same time the subdivision of subjects led to a dilution of quality, and a free bid for popularity and newspaper notice—which has rendered the proceedings of the Association of diminishing interest and value to the educated classes, not only in the locality of its meeting, but also throughout the country. Serious workers in science are now well provided in our great cities with societies and journals by aid of which new work may be discussed. No one is particularly anxious to follow the lengthy, and frequently non-authoritative, disquisitions which the sectional meetings, as at present organised, tend to promote.

The annual meetings of the Association might be carefully arranged beforehand by the executive so as to secure the consideration and clear exposition to the public of a few definite matters of actual moment. The "sections" of the meeting could with great advantage be reduced to four, and the addresses to be given by the president of each section, and also the "papers" accepted for consideration, limited to subjects chosen by the executive of the Association. The individuals chosen to preside or to introduce a subject should be men whose names and works are such as to command the attention and presence of the leaders of thought and social life in the district where the meeting is held.

The only wise alternative to this reconstruction seems to me to be a frank restriction of the meetings of the Association to men from all parts engaged in scientific work, glad to meet one another once a year in pretty and suitable spots (such as our old university towns and smaller cathedral cities), there to exchange in more or less intimate meeting—without the disturbing influence of newspaper reporters and notoriety hunters—recitals and exhibitions of the progress of their researches. Such are (or were) some of the associations of scientific workers in Continental countries. Meetings of this class involve little or no expense or trouble to their participants. The use for a week of a "refreshment hall" and public garden is all that is needful for the gatherings of the hundred or two *savants* who alone are eligible as members or anxious to be present. These meetings are often delightful, and lead to informal and productive discussions and personal friendships of permanent value.

I think that our "British Association" is in an unhealthy condition owing to the attempt made by it—not deliberately, but by constitutional looseness of purpose—to combine the features of a friendly picnic and smoking debate with the work of a national conference dealing (under the disadvantage of public ignorance and journalistic inaccuracy) with great questions of national importance. A choice must be made between "picnic" and "conference." I should prefer the picnic. E. RAY LANKESTER.

September 17.

YOUR criticism of the British Association, that it fails to touch our national life, is most opportune; but whereas you imply merely that it is decadent, to me it seems to be practically defunct. An active worker on its behalf in the past, I have little hope of its resuscitation and doubt if it can ever again fulfil the desires of its early promoters, who undoubtedly held its primary function to be that of advancing public appreciation of scientific discovery. I have always deplored our failure to appeal to the public. Seemingly, the spirit of sacrifice is gone out of science; strange to say, the herd instinct is altogether wanting in our society, so uncontrolled is our individuality. The assumed author of "The Beggar's Opera," after remarking of his characters, "There's not an honourable man among them, nor an honest woman," proceeds to say, "but they are all human." So are the present exploiters of the British Association, though were it not human to be selfish some might even dub them inhuman on account of the narrowness of their outlook and their disregard of public needs.

The neglect of science by the nation has long been the favourite text of the scientific preacher; it occurs to none to consider how complete is the neglect of the nation of which scientific workers have long been consistently guilty. Few seem to realise how great has been our failure of late to make any concerted effort to enlighten the man in the street, how little right we have to despise his ignorance. Scientific jargonese so fills the air that it would be refreshing to go back to Babylon and the Tower of Babel; scarce a readable book, fit for general consumption, is written on any branch of our scientific work. We ever walk on stilts; little wonder that the public does not reach up to us.

Like every other institution, the Association is a failure for want of leaders; and as discipline is gone out of society and children in these days think themselves superior to their parents—as demonstrated recently in the columns of the *Morning Post*—it is doubtful if, in the future, leaders will be recognised. Men with the Olympic genius of Huxley and with his profound belief in truth are creations of great rarity; even men like Michael Foster, his body-slave, are no longer to be found. Though not gifted with any high degree of imagination, Foster's was a sympathetic nature; he was ever on the look-out for suggestions and ever ready, when a good purpose was mooted, to help in bringing people together to accomplish it. The Royal Society has been a lifeless body since it lost his guiding hand; it has allowed its proper functions to be abrogated in every direction. Nothing, for example, could be more lamentable than its abandonment of the control of scientific research to the bureaucrats.

The British Association no longer has any real influence either on science or on the public. It has ceased to count, more especially since it lost the services of the late Mr. George Griffith, who rendered it such signal service while secretary. Griffith was the ideal official; he had feeling for every subject and his contagious influence in bringing about an understanding between elements often diverse in character was very great. He enticed all its members into active co-operation; his one desire was ever to make the Association of avail.

Of late years the secretariat has been a forbidding rather than an attracting institution; it has not only lacked imagination and "go," it has also had no ideals; and yet it has monopolised control, with the aid of a few elderly amiables who have been persuaded into the belief that they were bosses of the show.

The young man has been too little noticed; being afraid to speak out, feeling that his elders resent any expression of opinion, he has had no reason to take an active interest in the Association. The young man must be more cared for in future.

If the Association be continued, its constitution must be entirely changed. It is, perhaps, significant that at Cardiff the general committee relegated to a committee the appointment of a new treasurer—really a matter to be dealt with by the council. In point of fact, the council exists only in name; control rests with the official ring, who resent every criticism and any intervention with ideas. I would suggest that the two secretaries and the treasurer should each be appointed for three years, not more, so that every subject might be represented in turn; if only one of the three were appointed in any one year, the remaining two would always be men who had some previous experience of office. The council might consist of the officers, together with the president, the president of the previous year, the president-designate and a single delegate from each of the sections, half of these delegates being chosen afresh either each year or every other year. The business of the Association should be entirely carried out at meetings of the council, not settled previously by an official caucus. The delegate from a section should each year present a report to his sectional committee so as to bring the proceedings of the council under discussion.

The functions of the general committee need to be more clearly defined and perhaps limited; the "freak" has too great a chance at present and as no one knows what topic is to come under consideration, the discussions are rarely representative of the real state of opinion.

Of late the Association has lost what little hold it had on the public generally, owing to the commercialisation of the Press; even the *Times* is now given over to tit-bit-ery and the reports it prints of the Association meetings are worthless for all practical purposes. Some new method of running the scientific publicity campaign must be thought out. It may be worth while for the Association to spend its annual income on advertising in two or three of the chief papers, arranging that between them these report the proceedings in full. Money for research can now be had from other sources and the public has the right to demand that, being taxed for research, its contribution to the Association shall be used largely on its own behalf.

As to the work of the annual meeting, I am entirely with you in thinking that the sections should unite in treating subjects broadly on lines such as the Faraday Society has followed. Instead of a dozen separate sections sitting each year, it would be far better to have at most four.

The discourse delivered by Prof. Eddington may be referred to as an example of the address which appeals to specialists; it is of enthralling interest, yet far too technical; many of the conclusions arrived at need explanation to make them clear to the scientific mind not specially versed in the subject. Such an address, in fact, needs considerable working up to make it of avail even to the instructed reader.

Subjects can always be found on which we need posting up which are of general as well as of special interest; for example, what precisely is the present state of the evidence in favour of evolution? "General" Bramwell Booth scoffs at the conception as "stuff and nonsense." With what case can we confront him and literary quibblers like Mr. G. K. Chesterton? It is long since Huxley discussed the horse in public; in the interval much new evidence has been brought to light which should be presented. The chalk has told an undeniable story, yet how many know it? It is our own fault that the ecclesiastically minded, in their ignorance, speak of us as though we were mere speculators in knowledge, constantly shifting hypotheses without ever arriving at clear conclusions.

To mention other subjects, at the moment the fuel problem is one of the greatest importance; only the food problem is of greater urgency. On matters such as these the public stands much in need of enlightenment. Obviously, each town visited would be interested in having some particular subject special to itself treated exhaustively.

To make the meeting of more than local and passing value, the essays brought forward in the sections for criticism and discussion should be printed in advance and published, with the considered discussions, without any delay. Such a book of authoritative opinion could not but find a ready sale.

If something serious were attempted, something serious would be done. Now everything is attempted and little, if anything, done. Insisting, as we constantly do, on the value of education, it is imperative that we show ourselves educable and ready to read the signs of the times.

HENRY E. ARMSTRONG.

THE leading article in NATURE of September 16 gives articulation to notions which have been very prevalent of late. One does, indeed, occasionally hear the suggestion made that the British Association has outlived its period of usefulness, but most of us, I think, are of opinion that the virility of this nonagenarian institution is such that it should effect even more during its next ninety years than in its past to promote the objects laid down in clause 1 of chap. i. of its rules. One feels, however, that some infusion of modernity is necessary if the best possible future is to be built up upon the fine traditions of our Association. With your permission I will remark on certain impediments to progress resulting from the present form of organisation, and suggest, with some diffidence, a possible means for their removal.

The Association is really run by the general secretaries and the treasurer, with the technical members of the council as auxiliaries; these gentlemen are always chosen from the most eminent scientific talent of the country, and they constitute a body even more exclusive than the council of the Royal Society. None will doubt the thoroughly representative composition of the council, or that its members are doing less than their very best to promote the objects of the Association.

No executive body intervenes between the council and the sectional committees, and the latter meet only to settle the details of sectional procedure at the annual meeting; the general committee is merely a confirming body. In this detail of organisation seems to reside a notable defect. We should probably progress more rapidly if an intermediate set of men, chosen from among the more promising and active of the junior scientific men, were appointed to enunciate questions of policy, of initiative, and of action, and to put a definite scheme for each annual meeting before the council. The president-elect might act as chairman of this advisory body.

The council, meeting several times a year, cannot itself produce such a scheme. Its members are men who have filled most public offices in their respective professions and are distracted by a thousand calls upon their thought and time; they can, however, bring experience to bear towards amending and perfecting a well-thought-out plan of campaign laid before them.

The presentation of papers to sections as to an ordinary scientific society should, I venture to think, be definitely discouraged. The morning session of each section would be better occupied by a discussion upon some topic of immediate interest to the subject concerned; most large topics concern several sections of the Association, and these should amalgamate for a mutual exchange of views. If this mode of working were adopted as a general, rather than as an exceptional, practice, we should be spared audiences numbering about a dozen suffering under the vagaries of a lantern dimly burning.

The real feature of the meeting might well be made the delivery of semi-popular addresses by competent people on subjects of general interest. I have seen British Association evening lecturers, great authorities on their own subjects, but incapable of making themselves heard to a company outnumbering twenty, grappling with an audience of several thousands; the comments of these non-auditors have informed me of the extent to which such an exhibition promotes the objects of the British Association, and I can imagine the torments of the lecturer. One episode of this kind —it did not occur this year—does so much harm to science as to counterbalance the good results accruing from a dozen British Association meetings, and its recurrence should be made impossible. No professional class is, on the average, so competent to expound a good case as is that of the scientific man; anyone who has been in the habit of attending the Friday evening discourses at the Royal Institution will realise that this is a true statement. No class but ours, however, would commit the folly of inviting an incompetent exponent, of no matter what eminence, to address a general audience in the name of the community at large.

Dr. R. V. Stanford's view, that we ought to go to the British Association with a programme of fifty addresses to the non-scientific public, is, I believe, entirely sound. Such a programme could have been carried out at Cardiff; there were many present who combine high scientific achievement with marked expository power, but, apart from delivering themselves of a few impromptu remarks before sparse sectional attendances, these gentlemen perforce confined themselves to the object of their journey to Cardiff, and, like all the rest of us, thoroughly enjoyed their annual chat about scientific affairs with the many friends whom they had not seen since the meeting at Bournemouth last year.

If it be possible to construct such an aggressive plan of campaign as is foreshadowed by Dr. Stanford, some concrete object of attack must be selected. The following is merely a suggestion.

We are meeting next year in the intellectual centre of Scotland, in the capital town of a vast number of public-spirited and wealthy people. The University of Edinburgh is making a great effort to extend its science schools so as to bring them into line with present-day requirements. The objects of the Association would be well served by an intensive educational propaganda for the purpose of bringing home to wealthy Scotsmen what humanity, science, and the British Empire have to gain by the extension of liberal financial support to the University of Edinburgh. WILLIAM J. POPE.

The Chemical Laboratory, University of Cambridge, September 20.

I CERTAINLY agree in the main with the views expressed in the leading article in NATURE of September 16 on "The British Association and National Life." No one seems to be satisfied with the Association as it is, and the advance of the times has left it decadent just when it ought to be entering into its heritage. Any detailed criticism of the last meeting could scarcely fail to be invidious, but it could have given to few the impression that scientific men themselves are aware of the position science now holds in the community or realise that the vast body of the general public, disillusioned by the war, looks to them to provide a way of escape from the evils that threaten our civilisation. The Association provides an annual opportunity to honour by rotation and seniority a few scientific men by making them officials and inviting them to preside over its deliberations; to advance the numerous schemes competing for public money one or two at a time; to study human nature, another city and the surrounding scenery; but it makes no attempt to come to grips with the real enemy or to take the position already conceded by the general public to the spirit and service of science as almost the only disinterested and effective agency in a cannibalistic and corrupt society.

Surely ever so much more now than in 1831, when the Association started and when the broader implications of scientific discovery and thought upon human life were not dreamt of, is there need for an Association to insist upon a greater degree of national attention to the objects of science, and, it may be added, to its long over-ripe fruits neglected in order that everything old and out-of-date may be scrupulously retained. It is not too much to say that whole fields of government in the real sense, which is not the conventional sense of party politics, now fall wholly within the ascertained realm of science. A remark of Mr. H. G. Wells from his "Outline of History" concerning ethnologists, geographers, and sociologists may be generalised. All the monstrous turmoil and waste, the wonderful attitudes, deeds, and schemes of the "great men" deemed famous by the unscientific historian, might very well be avoided if Europe had the sense to instruct a small body of ordinarily honest scientific men to take over the work.

Whether the British Association can be of any real help in enforcing proper respect for the public position of science or not, it is clear enough to the man in the street that figs are not gathered from thorns. When he wants his appendix removed he does not brief an advocate to get up the subject for his particular case to persuade him that he has not got an appendix or, if he has, that it would kill him to have it removed. Neither are the national appendices rendered less painful by the men who talk of them as the essential parts of the British Constitution, which, with their felicitous assumption of office, has at length reached its final and perfect expression. The public, if not scientific men, know that scientific government is inconceivable without scientific men at the head of affairs.

It is amazing that, as in the example of the director of research to the Glass Research Association, science should be served by men with less respect for science and understanding of its powers apparently than the ordinary common-sense citizen. The peculiar thing is that one may attend learned societies and British Association meetings regularly without taking any part in the important work of selecting the officials, who apparently descend upon them in some mysterious fashion from heaven.

Unless the British Association becomes democratic and acts as a real bond of union between scientific men and the thinking public, rather than as a periodic platform for personages, it does not seem to fulfil any function worth continuing. The public application of science is a totally different thing from applied science. This scientific synthesis and the direction of the unique mental attitude, induced only by the actual discovery of new knowledge, to the conduct of public affairs are the real and peculiar functions of the Association if it is to regain its national position. Curved space, isotopes, and the economics of life on the floor of the ocean are topics of great interest to hundreds of the public. The standards of truth which science has set up, and the elevation of its pursuit above sophistry, chicanery, and the monotonous motives of self-interest, inspire the imagination of hundreds of thousands. The British Association seems to be attacked by senile paralysis just as a belief in science and in the power of its methods is arising in the world phœnix-like from the ashes of its old self.

FREDERICK SODDY.

THE interesting criticism by Dr. R. V. Stanford in NATURE of September 2 tempted me to write. Your leading article of September 16 makes me yield to the temptation. There are two lines on which comment may run: broad and narrow gauge. Taking the broad or general view first, we have to appreciate the fact that the changed attitude of the public to the Association is part of a widespread change in social life. Science is more taught in our schools, elementary scholars and others are introduced to it in our museums, and yet the number of keen naturalists in our local societies is decreasing, and the help of amateurs is a diminishing quantity. The opportunity of the war period and the subsequent economic pressure have driven all but a few to earn their living. Those really interested in science become professional workers therein; the others pass into their own special professions. Consequently, a body like the British Association has to rely more on professed workers in science and less on the amateurs and "camp followers," whose attendance the *Times* actually deprecates. But of the scientific workers many have had their fill at the end of a year's work, not to mention the society and committee meetings that accompany it. All they want is a holiday, and one as remote as possible from their daily avocation and surroundings.

Here we switch on to the narrow gauge. If you hold a meeting in August when one man is on the moors, another sea-bathing off the Land's End, and a third climbing the Alps, can you expect them to go to Cardiff? An attempt to facilitate the attendance of junior students was on the right lines and in harmony with the general trend; we may hope for a better response at a more convenient season. The local naturalists played up all right, but the other inhabitants were more interested in the tram strike and the coal strike than in hearing about aeroplanes or a grain of wheat, and so Sir Richard Glazebrook and Sir Daniel Hall delivered their popular lectures to benches two-thirds empty. Possibly Cardiff is more concerned with shipping than with aviation and agriculture. Again, the mid-week meeting, now tried for two years, seems less convenient than the old system.

Now for the sections. It is difficult to suggest practicable reforms. If you restrict the papers to popular expositions you may have the president and his faithful recorder confined to listen to what they know already, while the other constituents of the section flit dispersedly round other rooms. You ought to give the local workers a chance, anyhow; and there will always be a few people who wish to test some novelty on an audience of experts. How would it do to have one day for the more technical papers, one day for inter-sectional meetings, one day for broader expositions, and one day for the president's address, reports of committees, and what may be called scientific politics? These days should differ for the different sections, and certainly all the sectional presidents should not be addressing at the same hour. The Oxford Parliament of Recorders, held this year, effected some admirable arrangements on these lines, though the printing of the Journal beforehand set an ideal before sectional officers which they could not always live up to—and hence confusion to the public. Yet another suggestion comes from a camp-follower. Why not have "Section X, Popular Science," in continuous session, with a jolly president, a lantern that will work, and as many "star" performers as you can get? I think there's something in that. Of course, it must be properly advertised, and with figures more attractive than the aged dodderer who symbolises science for the Cardiff School of Art.

F. A. BATHER.

I WAS very glad to see the leading article in NATURE of September 16. You have directed attention with great force and point to the need for altering the methods of the British Association if its meetings are to retain the interest and attention of the public.

I doubt if at any time there existed a larger number of persons interested in science and with a keen appreciation of the practical value of science to mankind. But the excessive specialisation of British Association meetings has repelled instead of attracting their interest, and they have felt that they could not "see the wood for the trees."

After all, as you point out, one of the most important functions of the Association is to obtain the attention of the nation to the objects of science. It cannot do this unless it is willing to popularise its meetings, and I feel sure that your suggestions to associate with the meetings public men, whether of local or national distinction, and by grouping sections to obtain a broader outlook upon the scientific questions of the day, form a practical contribution towards the problem of how to revive public interest in the Association. I trust they will be seriously considered by the council. NEVILLE CHAMBERLAIN.

Westbourne, Edgbaston, Birmingham,
September 20.

THE stress laid in the leading article in NATURE of September 16 on "The British Association and National Life" on the importance of the "enlightenment of an extensive group of workers as to main lines of advance in fields not specifically their own" emboldens me to repeat a suggestion which I have often made and never found acceptable. It is that the presidential addresses in the sections should be placed in the foreground of the work of the Association, and so timed that an individual member could hear them all if he felt so disposed. The president of a section may safely be assumed to know his own subject, and he is usually able to express his views in language sufficiently explicit to be clear to everyone interested in any department of science. It is of vital importance to every scientific worker to know how his brethren are heading, were it only in order to see which lines are converging on his own, and which in the light of new knowledge may seem to be diverging from it. HUGH ROBERT MILL.

September 18.

I WISH, as a mere layman, to support the plea in your leading article of September 16 for more energetic and *popular* action by the British Association.

I am afraid that the responsibility both for the indifference, or even hostility, to science of Governments (of which Prof. Soddy complained in a recent letter), and for the lack of financial support from the general public, lies at the door of men of science themselves, who do not understand that they ought to carry on systematic educational propaganda as to the value of science in terms of the things that interest the ordinary man.

I will give three pieces of evidence:

(1) I am thirty-four years of age. I have never been directly appealed to for a subscription to any scientific society, and I have never been asked to join one.

(2) I have just recently looked through the file containing letters appealing for subscriptions addressed to a certain business firm during the twelve months ended August 31, 1920. I find there are just over 150 appeals, or say three a week. They range from hospitals to choral societies. Not one is for aid to scientific research. Most exceptionally, there is one for an educational institution, and part of the large gift made in response *may* go to research.

(3) I happened to remark to a well-educated and intelligent man who takes great interest in public affairs that I was glad to see that a large sum of money had been given for biochemistry. My friend replied that no doubt it was a good thing, but he was sorry that the donor had not rather given the money to reduce the National Debt! I think I managed to convince him that the money given to biochemistry would probably yield the nation thousands per cent. in mere cash, to say nothing of other benefits, *e.g.* health.

But this is what the average man—very naturally—thinks of scientific research, and will continue to think until men of science, or more properly their officials specially trained for the work, carry on systematic propaganda in the same way as hospitals, political organisations, and trade bodies do.

The love of science for its own sake is a special taste, like an interest in heraldry or stamp-collecting. If the men of science want the support of those who do not happen to share that taste, they must show the non-scientific man that science (unlike stamp-collecting) can confer real benefits, moral or material, on the world at large.

Governments move as they are pushed; if they have not moved to support scientific research, it is because there is no strong body of public opinion pushing them.

My practical suggestions are these:

Creation of a "Propaganda and Finance Department" of the British Association, with a permanent staff consisting of a director (responsible to the council of the B.A.); under him a publicity manager controlling a staff of journalists and a staff of lecturers, a financial agent controlling a staff of travelling collectors, with the necessary typists and clerks.

The working would be somewhat as follows: The publicity manager tells his journalists to "write up" the life and experiments of Faraday, showing the present results; particulars of the industries and benefits that have resulted from them; number of men employed; dividends paids; number of tramcars running; and need of financial support for "our modern Faradays." This to be embodied in (i) lectures—for the travelling lecturers; (ii) posters; (iii) booklets and pamphlets for the use of the travelling collectors; and (iv) letters to the Press, especially the provincial and local Press.

After a certain district had been well "treated" with this propaganda, a travelling collector to be sent to interview individuals, firms, chambers of commerce, trade unions, and so on. These collectors would have to be men of high capacity and tact. They would endeavour to get (1) subscriptions and (2) new members of the B.A.

A few thousands a year spent in this way would produce easily an income of 500,000*l.* a year in subscriptions and donations, to say nothing of the other advantages that would flow in.

One useful means of propaganda would be a "Science Day" on the lines of Lifeboat Saturday. Another would be a "Review of the Year's Work" in each branch of science in non-technical language. FRANK R. EAST.

9 King Edward's Road, Swansea,
September 18.

Relativity.

THE examples considered by the theory of relativity appear to have become somewhat stereotyped, and to deal mainly with problems of optics and electrodynamics. The specification of "simultaneity" seems to be regarded as necessarily involving the use of rays of light. The following suggested examples may perhaps be of interest. They are not put forward as possible "objections" to the theory, but with the same intention as prompted the supposed "exceptions" to the second law of thermodynamics. The latter, although they did not disturb the application of the law in its proper sphere, led to drastic limitations to its general validity (*e.g.* the "sorting demons" of Maxwell).

Consider first a cube of unit volume, constructed of rigid material absolutely impervious to heat. Suppose the cube contains a gas the temperature of which, measured by an observer rigidly attached to the box, is T. What will be the temperature as measured by another observer moving relative to the first with a uniform velocity v in the direction of one of the edges of the cube? The volume of the cube as measured by the second observer will, according to the theory of relativity, be reduced to $1/\sqrt{1-v^2/c^2}$. If the same laws hold for the gas for both observers, the temperature of the gas would seem to be $T(\sqrt{1-v^2/c^2})^{\gamma-1}$. We note in passing that this depends on γ, the ratio of specific heats, and thus on the structure of each of a definite number of molecules of gas contained in the cube. If the gas is supposed to be the mixture $2HI \rightleftharpoons H_2+I_2$, the extent of dissociation depends only on the temperature and not on the volume, and could be measured by the change in intensity of a beam of light passed through the box in a direction at right angles to its motion, and received by the second observer. The consideration of the case in which the cube is at rest and the second observer in motion would naturally follow. The detailed consideration of this case would appear to involve the transformation of the statistical equations for the energy and entropy of the gas in terms of the position and momentum co-ordinates of the molecules, but I must defer detailed discussion of this matter at the moment.

In the next case we will consider a possible definition of "simultaneity" not involving the use of rays of light. A chemical reaction taking place with a measurable velocity in a given position as measured by an observer at rest is employed. A solution is divided into two equal parts. One remains with the observer at rest, the other is taken by a second observer anywhere he pleases. When an event occurs simultaneously with respect to the two observers the chemical reaction is stopped and the solutions are brought back to the original position and analysed. Let us say that if equal amounts of substance have been changed the events were simultaneous. What objection is raised to this definition? As a further case, we may consider both observers provided with equal weights of radium, and instructed to measure time by counting the number of α-particles emitted from a given instant. This change is found by experiment to be independent of external conditions. If we assume the use of rays of light as a standard method, it follows that the rate of disintegration (and the rate of a chemical reaction) will depend on the velocity. A possibility of testing this by experiment with a centrifugal machine at once suggests itself. I find by calculation, however, that according to the theory of relativity the rate of emission of α-particles would not, in the most favourable circumstances, be changed by more than about one particle per second per gram of radium (see also A. H. Compton, *Phil. Mag.*, 1920, vol. xxxix., p. 659).

Attention may perhaps be directed to the calculation of Bucherer (*Physikal. Zeitsch.*, 1920, vol. xxi., p. 451), who shows that the displacement of spectrum lines may be calculated without the assumption of a general theory of relativity from the principles of thermodynamics. The deflection of light by the sun may yet be shown to depend on the condensation of æther—a hypothesis first put forward by Newton (Boyle's "Works," ed. by Birch, 1744, vol. i.). Neither of these tests appears to be crucial.

The possibility of an upper limit of temperature, when a particle attains by thermal processes a velocity c, is complicated by the change of mass with velocity. In the case of electrons it is further complicated by the doubt as to whether they can be set in motion at all by thermal means, which follows from the values of the specific heats of metals at low temperatures.

J. R. PARTINGTON.

East London College.

Variations of Eucalyptus Foliage.

THE eucalyptus tree is a common object in the gardens of Torquay, where it grows freely, though subject to having its tender branch-ends killed occasionally by frost-laden winds. In the King's Gardens here there are two of these trees of the same age which are remarkable for the contrast in the appearance and character of their foliage. One is bearing almost entirely long scimitar-shaped leaves that are petiolate and grow alternately on the branches with that pendulous habit which so characterises these plants. Its companion has a more robust appearance, and bears only the more or less elongated heart-shaped leaves that are erect, opposite, and sessile, with more of the grey-blue gummy exudation that gives them the common name of blue gum trees. It has been noticed that this plant had lost its leading shoot when very young, so that its mass is formed of branches grown from lateral buds. A few trunk shoots have appeared this season among the lower branches on the northern side of the companion tree first mentioned that bear the opposite, sessile leaves characteristic of the young plants, and a recently pollarded tree in a private garden near has developed two shoots from apparently the same lateral bud on the north side of the tree, that bear respectively the two forms of foliage, while a sheltered and uninjured tree in the Terrace Gardens of some 30 ft. in height has only the pendulous type of leaf upon it.

These observations, while bringing to notice a remarkable instance of reversion to seedling or ancestral characters, seem to indicate that with these plants light and temperature under the effects of injury influence their development relative to temporary or permanent reversion.

HARFORD J. LOWE.

The Museum, Torquay.

Old Road Maps.

THE reference in NATURE of September 16, p. 90, to John Cary's old road map prompts me to send particulars of an old and rare book, "A Pocket-Guide to the English Traveller: Being a Compleat Survey and Admeasurement of all the principal Roads and most considerable cross Roads in England and Wales," by Thomas Gardner, 1719. There are one hundred copper-plate engravings showing the roads, with the bridges, woods, inns, churches, beacons, gallows, etc., passed *en route*. The scale is, for the actual roads, about one inch to the mile, and every mile is numbered. This book has been in my possession for more than forty years, and I have never met anyone who has seen another copy. It is dedicated to "His Most Serene Majesty George, King of Great Britain, France and Ireland, etc."

C. CARUS-WILSON.

September 17.

The Electrical Transmission of Pictures.

By Philip R. Coursey.

The art of the transmission of a picture or drawing by electrical means from a given place, so that it can be reproduced in another, may, speaking generally, be said to date from the perfection of Bain's early chemical telegraph about 1842. In its original form Bain's apparatus was devised for purely telegraphic purposes for the reproduction of the given message at the distant station: with this in view, the message was set up in metal type at the transmitting station, and was connected up with a battery, a number of metallic contact brushes, and a series of line wires between the two stations, so that by moving the brushes across the metallic letters a series of electrical impulses was sent out along the various wires, depending upon the form and arrangement of the letters. At the receiving station a similar series of metallic brushes was passed over the surface of a paper strip, soaked in a solution of potassium iodide in starch, with the result that whenever a brush at the transmitter rested upon a metallic part of a letter a current flowed through the corresponding line and through the wet paper strip at the receiver, decomposing the KI solution and giving a blue stain through the reaction of the free iodine with the starch. The resultant marks therefore corresponded with the form of the letters arranged at the transmitting station.

A very slight modification of this simple apparatus would enable it to be employed for the reproduction at a distant place of any sketch or line drawing, and, in fact, also of any picture or photograph not having too fine detail. In the case of a photograph, the reproduction at the receiving station would resemble a print from a block of the picture made with a rather coarse screen. This "screen" in the resultant reproduction constitutes the most serious limitation in the quality of the work produced by any of the known methods of photography, and no very obvious way of overcoming this defect is yet apparent. It may be minimised by accurate mechanical construction of the transmitting and receiving mechanism, and by enlarging the original picture photographically before transmission, so that subsequent reduction of the received reproduction will render the screen less noticeable.

The apparatus might be arranged somewhat as indicated diagrammatically in Fig. 1. A cylindrical drum A is fitted with a small contact brush B electrically insulated from, but moved by, the fine pitch screw S, geared by the wheels W to the axis of A. The brush B, therefore, traces out a spiral path on the surface of A when the drum is rotated. At the receiving station, an exactly similar drum D and contact C are provided, the two being electrically connected together through the line wires. Each cylinder is provided with a driving mechanism—of clockwork or other convenient motor—and some governing mechanism to maintain a constant speed. Exact synchronism between the two cylinders is essential if an accurate reproduction is to be obtained. Uniform driving is therefore necessary unless arrangements are made for synchronisation at the beginning of each revolution by means of a special synchronising impulse between the two stations. A phonic wheel, or some similar motor, may be employed with advantage.

For transmitting the impulses to the line wires with such an arrangement as that outlined above, the original picture may be reproduced in metal by

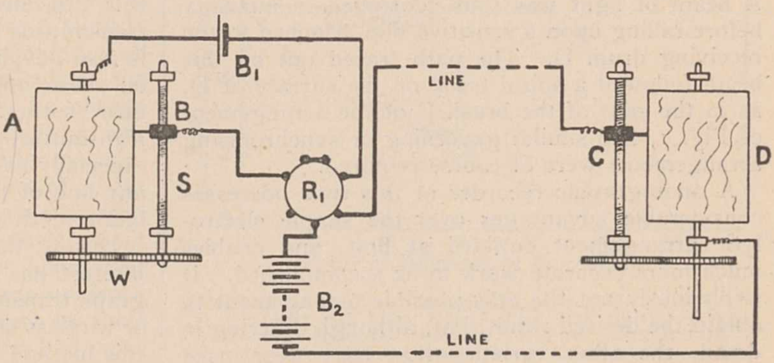

Fig. 1.

an ordinary block-making process, and attached to the cylinder A. Contact will therefore be made with the brush B, as the cylinder revolves, at all points which would mark the paper were the same block used for ordinary printing. For the reproduction at the receiver an electrolytic arrangement similar to that of the original Bain telegraph may be employed, using potassium iodide and starch for the electrolyte, or potassium ferrocyanide with an iron electrode brush C.

This apparatus in its simple form is evidently suitable only for reproducing sketches or drawings of which ordinary line blocks can be prepared, but with an improved receiver, such, for example, as the photographic one described below, a "half-tone" block made from a photograph could evidently be used, if the screen were not too fine. For satisfactory reproduction the travel of the brush B per revolution of A should be equal to the distance between the screen lines.

The repeating relay R may be placed when required between the transmitter and the lines to enable smaller control currents to be employed. A similar relay may be placed at the receiving end, if the incoming current is too weak.

As an alternative to making a metal reproduction of the original picture for transmission by this method, a photograph of the original may be printed on to a sensitised gelatine film on the metal cylinder A, and the parts unaffected by light washed away to leave the metal exposed, so that contact may be made with the brush B.

One of the best known practical developments of photo-telegraphy was made by Dr. Korn some twelve years ago. In his apparatus the original picture was photographed on to a transparent film, which was then wrapped round the cylinder A—in this case made of glass. Instead of the contact brush B, a fine pencil of light was used, which, after passing through the film, fell on a sensitive selenium cell and thus modulated the current flowing out to the lines in accordance with the opacity of the film. At the receiver the incoming current was passed through a special form of galvanometer—practically a double-thread Einthoven galvanometer—so that a light aluminium shutter was moved aside to a greater or less extent, depending upon the strength of the current. A beam of light was thus controlled in intensity before falling upon a sensitive film attached to the receiving drum D. The path traced out by this beam followed a spiral track on the surface of D, as in the case of the brush C of the arrangement of Fig. 1, and similar governing or synchronising arrangements were of course required.

A photographic recorder of this type possesses considerable advantages over the simple electrolytic arrangement outlined at first, and enables much more accurate work to be accomplished. It is obviously not the only possible arrangement to obtain the desired result, but, although differing in detail, the other varieties that have been used operate upon similar principles.

The chief disadvantage of the selenium-cell modulator at the transmitting station is to be found in its inertia to rapid changes of illumination, with the consequent limitation of the speed of operation. In the practical apparatus a compensation arrangement was employed to increase the speed of transmission, but better results would be possible with a light sensitive material having less lag. Some of the more recently discovered sensitive materials may prove better in this respect.

An ingenious alternative transmitter has recently been put to practical test. The photographic print of the original picture at the transmitter is made in gelatine or similar material, giving a relief print when "developed." Instead of passing a metallic contact over such a print, a needle is used in such a manner that difference in relief varies the resistance of a microphonic contact, and thus controls the line current. The reproduction at the receiving station is effected with a photographic apparatus of the type described above.

From the transmission of pictures by wire, it is but a relatively small step to their transmission by radio. In the earlier stages of wireless development attempts were made in this direction with more or less success, but the irregularities of the coherer, which was at that time the only receiver capable of controlling sufficient local energy to operate the recording apparatus, prevented the practical development of the method. With the modern three-electrode valve receivers and relays this difficulty is removed, and their use at the transmitting station as continuous-wave generators is also advantageous. Considerable developments on these lines may therefore be expected in the near future. In particular the last described transmitter, with microphonic control, should be especially easily adaptable to radio work by using any one of the well-known radio-telephone modulation methods.

During the last few months some considerable interest has been aroused by a method of photograph transmission applicable to either wire, cable, or wireless signalling. Strictly speaking, however, this method is not of the same class as the above, in which the picture itself controls the actual signalling currents, as the transmission is effected by a series of code letters, words, or numbers, sent as an ordinary telegraphic message between the two stations. By this method the original picture is divided up into a number of small units, and a code letter used to designate the condition of light or shade in that unit, thus enabling a complete code message to be built up to represent the whole picture. At the receiving station the decoding may be effected in an obvious way, or a mechanical decoding machine may be employed to reproduce the picture.

The Structure of the Atom.[1]

By C. G. DARWIN.

III.—*The Nucleus.*

IN the previous articles we discussed the nucleus mainly in connection with the idea of atomic number. We shall now return to the characters of the nucleus itself; but before doing so it is necessary to say something about the atom as a whole. Comparatively little is known about the electrons surrounding the nucleus—it is not even universally agreed whether they are at rest or in motion—but a successful beginning has been made by the Bohr spectrum theory, which applies mainly to the specially simple case of hydrogen. On the same lines Sommerfeld has also had some success with the X-ray spectra. It is quite certain, as in all questions of atomics, that the laws of classical dynamics do not hold, and the principal method in research at present consists in a judicious mixture of these laws with the quantum theory. This latter theory is definitely contradictory not only to the laws of mechanics, but also to almost any conceivable modification of them, and its chief justification, an entirely adequate one, is the astounding success with which it has

[1] Continued from p. 83

been extended over more and more branches of physics.

We shall not deal here with these spectroscopic questions, but it will be convenient to have a definite idea of the scale on which the atom is built. The proportions of its parts vary over so wide a range that no drawing can possibly represent them. We shall be dealing with magnitudes as small as 10^{-16} cm., and as these large negative indices convey little definite to the mind, it will be convenient in describing the atom to raise the whole scale by 10^{13}. On this scale 1 cm. would become a length about two-thirds of the distance from the earth to the sun. The outermost electrons of the atom would be about a kilometre from the nucleus, and for the heavier elements the innermost, perhaps three in number, would be roughly 10 metres from it. As to the nucleus itself, there is definite evidence that it is less than 30 cm. in radius, and, in some cases at any rate, that it is greater than 2 cm. Other physical quantities which we shall require are of a slightly more hypothetical nature. On the theory that all mass is electromagnetic, we can calculate the radius of an electron, since we know its charge and mass. This radius comes to about 2 cm. (actually $1{\cdot}88 \times 10^{-13}$ cm.). By a similar calculation the hydrogen nucleus has a radius of about one-hundredth of a millimetre. The same argument would make the radii of heavier nuclei about as small as this, but would not be justifiable, because, as we shall see, there is clear evidence that these nuclei owe their large mass to their being composite structures built up from hydrogen nuclei and electrons. From the extraordinary smallness of the quantities we have considered, it is not surprising that experiments with the nucleus should be very difficult. We now turn to these experiments.

When first describing the nucleus, in the first article, we saw that when an α-particle goes near it, it describes a calculable orbit, so that we can find a distance of closest approach between the two. As the predicted law of scattering was borne out by experiment, we can conclude that the law of force at this distance of closest approach (3×10^{-12} cm. for gold, above called 30 cm.) is still the inverse square law. Therefore the sum of the radii of the α-particle and the nucleus must be less than this. But a different case has been studied in great detail by Rutherford. Where the α-particles are passing through hydrogen, the repulsive forces between the nuclei are much weaker than for other substances, because the atomic number of hydrogen is only 1, and so the nuclei can get much closer together. But there is also another difference, for the hydrogen nucleus has mass only a quarter of that of the α-particle. Consequently, if there is a "straight on" collision the hydrogen is shot forward at a speed higher than that of the colliding α-particle, and the latter follows on behind with reduced speed. This new type of particle, the H-particle, then proceeds to traverse any matter in its path, losing speed in the same sort of way as does an α-particle, and it can be calculated that, whereas the fastest α-particles go through only 7 cm. of air, the fastest of these H-particles should go through 28 cm. (Fig. 2). Experiment bore out this prediction, but when the calculation was pushed further so as to show how many should go various distances from 28 cm. downwards, a very wide difference was found between theory and experiment. This indicates that there is something wrong with the theory—in fact, that the approach between the nuclei is so close that the ordinary law of repulsion fails. This ordinary law would give 2×10^{-13} cm. as the distance of closest approach, and we therefore conclude that the sum of the radii of the hydrogen and helium nuclei is greater than this. Now the radius of the electron is about 2×10^{-13} cm., and the coincidence of these two numbers tends to support the view that there are electrons in the nucleus of the helium atom.

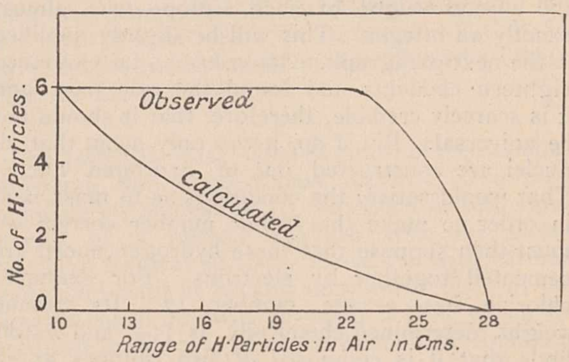

FIG. 2.—From Sir Ernest Rutherford's paper "The Collision of α-Particles with Light Atoms" (*Phil. Mag.*, xxxvii., p. 549). The wide difference between the "observed" and "calculated" curves shows that the assumed law of force between α-particle and H-nucleus is wrong; in fact, that a lower limit has been obtained to the size of the nucleus.

Turning now to the constitution of the nucleus, the first piece of information is provided by radio-activity. In successive radio-active transformations α- and β-particles are projected from the nucleus. Therefore the latter must contain both—that is, helium nuclei and electrons. Next we have the evidence from Rutherford's transmutation of elements. The experiments in which this occurred consisted in the bombardment of various elements by α-particles. When nitrogen was tried, he observed that a certain number of H-particles was obtained. As no hydrogen was present, we are compelled to conclude that these particles were knocked off the nuclei of the nitrogen atoms; so we can be confident that these nuclei contain hydrogen nuclei. In recent work Rutherford has got even further, for he has found another entirely new type of particle which is sometimes knocked off nitrogen and oxygen. These particles have atomic mass 3 and number 2, so that if they were obtained in bulk they would be helium of density 25 per cent. less than ordinary helium. It is at present unknown what happens to the remainder of the nucleus after these losses. A point of great interest in this work is that the new particles come off with greater energy than that of the bombarding α-particles. If we carry over the language of chemistry to this new domain we should say that the reaction is exothermic, and nitrogen in a metastable state.

We have so far discussed the special properties of particular elements. The next evidence is very much more general, and holds out great promise of extension. This is the recent work of Aston with the "positive rays." It was undertaken in order to detect whether ordinary elements were composed of isotopes. He found that this was true of the majority of those he examined (his numerical results are given in the table in the first article), but the important result from our present point of view is that in all his elements the atomic weight of each isotope was almost exactly an integer. This will be slightly qualified in the next paragraph. Aston has so far examined eighteen elements and found the rule true, and it is scarcely credible, therefore, that it should not be universal. But if so, it can only mean that all nuclei are constructed out of hydrogen nuclei. That would satisfy the conditions as to mass, and in order to make the atomic number correct we must then suppose that these hydrogen nuclei are cemented together by electrons. For example, chlorine has atomic number 17. Its atomic weight, determined chemically, is 35·5, and Aston finds that it is composed of two isotopes at 35 and 37. Therefore three-quarters of the chlorine atoms have nuclei composed of 35 hydrogen nuclei and 18 electrons, while for the remaining quarter the numbers are 37 and 20 respectively. This is the revived form of the famous hypothesis of Prout.

Aston's experiments have not hitherto been sufficiently accurate to detect any departures from the whole number rule, except in the case of hydrogen. In this case his work confirms the chemical result that the atomic weight is 1·008 instead of being 1. At first sight this would appear to dispose entirely of the validity of our interpretation of the whole number rule, but that is not so, and by the use of arguments based on the work of Einstein on relativity, the departure from whole numbers can be made to yield valuable information. Einstein's theory implies that all energy must have mass (and also that all mass must have weight). Thus the mass of a helium nucleus (at. no. 2 and at. wt. 4) will not be simply the sum of the masses of its four α-particles and two electrons, but will also include the mass of its energy of formation. As the helium is lighter than the sum of the weights of these particles, we conclude that this energy is negative—that is to say, an atom of helium has less energy than its separated particles. Lenz has calculated the difference and finds that it corresponds to the energy of about three of the fastest α-particles. So helium is an exceedingly stable substance, and it need create no surprise that its nuclei, when projected as α-particles, can undergo the most violent collisions without disruption. It also makes it not unnatural that in radio-active disintegration it is helium, and not hydrogen, that is emitted. Moreover, it is well known that the atomic weights of most elements are nearer whole numbers when helium is taken as standard at 4 than when hydrogen is taken as 1. This indicates that in most atoms the majority of the hydrogen nuclei are bound together in helium sub-groups.

It will thus be seen that a very promising beginning has been made in the study of the nucleus. We know that it is built up of hydrogen nuclei and electrons, and that there is a strong tendency to form helium sub-groups. We know the number of hydrogen nuclei and electrons in the nuclei of many of the elements, and may expect to know those of the majority at no distant date. Most encouraging of all, we may hope that it will not be very long before a definite theory of the structure of nuclei is made, based on exact knowledge of the energy of formation of the various elements.

Obituary.

THE RIGHT HON. SIR WILLIAM MATHER.

WE deeply regret to record the death of Sir William Mather, at his residence in the New Forest, on Saturday last, September 18. Sir William was born in Manchester in 1838, and educated at private schools, and his studies were continued under one of his English tutors at Dresden. Afterwards he entered his father's engineering firm, well known as the Salford Iron Works, and worked the usual hours of apprentices, in the evenings attending lectures at the Owens College, Manchester. In 1862, when he was twenty-four years of age, he became solely responsible for the management of the business. The firm enjoyed great repute as makers of bleaching, dyeing, finishing, and other textile machinery, exporting its products abroad, especially to Russia and the United States, in which countries Sir William travelled extensively. He took the greatest interest in the well-being of his employees, his firm being among the first to establish the eight hours' day, and providing for his young workers, more than forty years ago, the means of continued instruction in the fundamental principles of engineering science, at the hands of his chief technical officers, and with striking results, many of the students gaining Whitworth and other science scholarships.

Sir William Mather took a deep interest in local affairs and movements, was a member of the

Salford School Board for ten years, from 1872, and for a time on Salford Town Council. He also entered Parliament, where his intimate knowledge of industrial and educational matters proved of the greatest service. On the appointment of the Royal Commission of 1881 on technical education at home and abroad, the report of which did so much to direct the attention of the nation to its shortcomings in the means of education and training in science and its applications, Sir William Mather, because of his intimate experience of the conditions of industry in the United States and Russia, accepted the position of special commissioner in those countries and wrote two valuable reports which were included with that of the Royal Commission. The inquiries of this Commission undoubtedly led to the passing of the Technical Instruction Act of 1889 and to the subsequent Excise and Customs Act of 1890, by which a fund of 800,000*l*. was placed at the service of technical instruction.

Sir William Mather's intimate association with educational institutions in the United States, and his sympathy with the system of manual training prevailing there, enabled him to invite its chief exponent, Prof. Woodward, of St. Louis, to a conference in Manchester in 1882 on "Education under Healthy Conditions," with the result that there was established in the Manchester Mechanics' Institution the first manual training school in Great Britain. He gave to Chetham College (for orphan boys) in Manchester a complete manual training equipment, and likewise did the same service for the engineering department of the college at Khartoum, in the Sudan. He identified himself with all types of educational advance, founding in Manchester the Mather College for the training of kindergarten teachers, and taking a deep interest in the activities of the Union of Lancashire and Cheshire Institutes, of which he was president from 1908 until 1919, in connection with which he founded a valuable scholarship and exhibitions.

One of the chief features of the Franco-British Exhibition of 1908 was the fine display of British educational enterprise, which owed its initiation to Sir William Mather, and of which he bore the entire cost. The value of the exhibition was much enhanced by the addresses of eminent educationists whom he invited. He was a warm supporter of the British Science Guild, founded in 1905, and was its president from 1913 to 1917. He regarded it as "a body capable of development up to the rank of a powerful national institution permeating the industrial life of the Empire with the fruits of scientific research," and to it he gave the most liberal financial support. On the foundation of the Association of Technical Institutions he became its first president, and gave it effective aid in many ways. By Sir William Mather's death the causes of education and of scientific efficiency in industry suffer an almost irremediable loss. He was laid to rest on Wednesday in the grounds of Prestwich Parish Church, near Manchester.

THE death is announced, on August 19, at fifty-six years of age, of PROF. T. RIDLER DAVIES, associate professor of mathematics at McGill University, Montreal.

SIR WILLIAM BABTIE, V.C., who held many important posts in the Army Medical Service, died on September 11, in Belgium, where he was spending a holiday. Sir William was born in 1859 at Dumbarton, and was educated at Glasgow University, where he took his M.B. degree in 1880. In the same year he became L.R.C.P., L.R.C.S. of Edinburgh, and in the following year entered the Army Medical Service, of which he was made Deputy-Director-General in 1910. He retained this post until 1914, when he was appointed Director of Medical Services in India; later he filled the same office in the Mediterranean. He was created a K.C.M.G. in 1916 and a K.C.B. in 1919, and was known as an administrator rather than for his medical work.

SIR JAMES B. BALL, chief engineer of the London, Brighton, and South Coast Railway, who died suddenly on September 17, was born in 1867, and started as a railway engineer with the Great Northern Railway in 1890. He served with various companies until he became engineer-in-chief of the Great Central Railway in 1912, a post which he occupied until 1917, when he went to the London, Brighton, and South Coast Railway. During the latter part of the war, Sir James Ball was appointed Controller of Timber Supplies for the Board of Trade, and in 1918 he was knighted. He received the Telford gold medal of the Institution of Civil Engineers, and was the author of several technical papers communicated to that body. His work included the design and execution of many large-scale railway and dock enterprises.

SIR J. W. BYERS, one of the leading physicians of the North of Ireland, who died on September 20, was born in China in 1853, but was educated and spent his life in Belfast. He commenced practice in the Children's Hospital at Belfast in 1879, and in 1882 he took over the department for diseases of women in the Royal Victoria Hospital in that city. In 1896 he was elected honorary president of the International Congress of Obstetrics and Gynæcology. He was president of the Section of Obstetric Medicine and Gynæcology of the British Medical Association in 1901, and from 1902 to 1906 was a member of the council of that body. In 1907, Sir John Byers was president of the Section of Physical Education and Training in Personal Hygiene of the International Congress on School Hygiene, and in 1916 he was knighted. During his lifetime he took a prominent part in all movements concerned with public health, particularly those dealing with tuberculosis and infant mortality. He was the author of many medical works, and of some papers and a book on the folklore of Ulster.

Notes.

THE sixth International Congress of Mathematicians is being held this week at Strasbourg. It is eight years since the last congress was held at Cambridge, and it will be noted with regret that the then honorary president, Lord Rayleigh, and the president, Sir George Darwin, are no longer with us. The present meeting was fixed for this year at the Allied Conference of Scientific Societies held in Brussels in July, 1919; its organisation has been in the hands of the Comité National Français de Mathématique, of which M. Emile Picard is president, and of a local organising committee (president, M. Villat). On Wednesday, after the congress had been formally opened by M. Alapetite, Commissaire Général de la République, the members proceeded to elect their president and other officers. In the evening a reception was held by the organising committee in the Salle des Fêtes. In the course of the meeting lectures are being given by Sir Joseph Larmor (Thursday), Prof. L. E. Dickson (Friday), M. de la Vallée-Poussin (Saturday), M. Volterra (Tuesday morning next), and M. Nörlund (Tuesday afternoon). On Friday evening Gen. Tauflieb will give an address on "Science in Alsace." Conducted visits have been arranged to the cathedral and the museums, and excursions to the ports of Strasbourg and Kehl, to Saverne, and to Linge. At the end of the proceedings on Tuesday, September 28, the members will be entertained at a banquet kindly given by the organising committee. There is every prospect of a successful meeting, and it is anticipated that the members will have much of interest to communicate after being out of touch with each other for so long a period. On the eve of a new academic session English mathematicians are finding some difficulty in attending; only ten entries have so far been recorded from the United Kingdom.

SOME time ago the National Sea Fisheries Protection Association initiated a movement for the creation of a British Fisheries Society. A draft charter and by-laws have been prepared, and anyone interested in this matter can obtain a copy of the draft by-laws from Capt. G. C. L. Howell, Gadesprings, Hemel Hempstead. The proposal is to organise the society in two divisions, (1) industrial and (2) scientific, intelligence and general. Each division is organised in sections, fourteen in all, and these represent every interest in the fishery industry, producers, manufacturers, and distributors. Presumably the society as a whole will hold periodical meetings, and at these matters affecting the industry will be referred to the sections as committees. Proposals for a Journal, Transactions, and Proceedings, as well as for the institution of a library and museum, are outlined, and, in general, the objects of the society are to gather and diffuse information upon all matters relating to the fisheries and to unite all interests and affiliate the various bodies at present in existence. It is supported by a number of men very well known in the fishing industry.

WE have received notice of the forthcoming establishment in the University of Paris of an Institute of Psychology. The institute will be administered by a council composed of Profs. Delacroix, Dumas, Janet, Piéron, and Rabaud, and the Deans of the Faculty of Letters and Sciences. It will afford instruction, both theoretical and practical, in general, physiological, experimental, pathological, and comparative psychology. To it will be attached the recently established Institute of Pedagogy, forming its pedagogical section. Other sections of the institute, dealing with the general applications of psychology and with vocational selection, will be formed shortly. The institute will grant diplomas to successful students in each of these sections and to those who, after attending other courses of instruction, have passed the examinations therein. It will also be open for research work in connection with the University doctorate or higher diplomas. This union of Parisian psychologists can but strengthen the position of psychology in France. Previously Prof. Janet with his colleague, Prof. Dumas, worked in psychopathology quite independently of the late Alfred Binet, who directed the psychological laboratory. Prof. Piéron, Binet's successor, is now joining forces with the most famous representatives of French pathological psychology, and the institute thus formed is also to encourage the applications of psychology to education and to industry. The institute deserves to achieve success, and it has our best wishes.

A SUMMARY of the weather for the summer season, comprised by the thirteen weeks from May 30 to August 28, is given in the Weekly Weather Report of the Meteorological Office for the week ending August 28. The absolute highest shade temperature for the whole of the British Isles was 81° F. in Scotland E. and the Midland Counties, whilst in seven out of the twelve districts into which the country is divided the temperature failed to touch 80°, the highest temperature in England S.W. being 75° and in the English Channel 73°. Frost was registered in three of the five eastern districts. The mean temperature for the summer was below the average over the whole of the British Isles, the difference ranging from 0·5° F. in Scotland N. to 1·6° in one-half of the eastern and western districts. The essential feature of the summer was the persistent cool weather, and particularly the absence of warm days. At Greenwich the coldest of the three summer months was August, with a mean temperature of 58·7°, which is 4·2° below the average for seventy years, and there were only eleven days with the thermometer 70° or above against an average of twenty-one days. August of 1912 was slightly cooler, but this is the only exception since 1841. The mean temperature for the whole summer at Greenwich was 60°, which is 2° colder than the normal. The Meteorological Office record for the summer shows that the amount of rain was in excess of the normal except in Scotland N., England E., and Ireland. The greatest excess was 1·85 in. over the north-west of England and 1·77 in. over the south-east of England. The highest total fall was 11·77 in. for Scotland W., the least 6·25 in. for England E. July was generally the wettest summer month. The duration of bright sunshine was less than the normal except in Scotland N. and E.

THE annual exhibition of the Royal Photographic Society is being held at the society's house, 35 Russell Square, W.C.1, and will remain open until the end of October. It is divided into three sections, namely, pictorial photographs, colour transparencies, and scientific and technical exhibits. The last is exceptionally rich in radiographic and astronomical photographs. Mr. Luboshez has a room to himself in which he shows several series of X-ray negatives on "Eastman duplitized film," made to find the methods of getting the best results in normal and adverse circumstances. The Sunic Research Laboratory shows radiographs of iron and steel welds, a carbon block, and a Palmer aero tyre, besides a "radiometallograph of thumb," which shows the lines and dots of the skin with great clearness. The other radiographs include a fine series by Dr. Robert Knox. The Astronomer Royal sends series of photographs of the total eclipse of the sun in 1919, the great sun-spot of March, 1920, and the new star in Cygnus. A number of fine photographs of the moon and two of the sun is contributed by the Mount Wilson Observatory. The research laboratory of the Eastman Kodak Co. sends some very interesting experimental results. There is a large number of natural history subjects. Some of the most notable are the president's coal-plant fossils; a tree in California which is supposed to be the oldest living thing, as it was a sturdy tree when Moses was a boy, contributed by the National Geographic Society of Washington; and Mr. Hugh Main's studies of the metamorphoses of beetles and other insects which take place underground, obtained by means of his "Subterrarium." Mr. Alfred E. Tonge sends sixty photomicrographs of the ova of British butterflies, including every genus as enumerated in "The Butterflies of the British Isles," and there are other photographs of entomological, botanical, geographical, zoological, and mathematical interest, besides some excellent aeroplane photographs by Capt. F. R. Logan.

THE annual meeting of the British Mycological Society will be held at Minehead from September 27 to October 2. On Wednesday, September 29, Mr. T. Petch will deliver his presidential address on "Fungi Parasitic on Scale Insects." There will be excursions each day, and in the evenings of September 30 and October 1 the following papers will be read:—The Action of Gravity on the Fungi, Dr. Harold Wager; The Genus Ganoderma (Karst), Pat, Carleton Rea; The Mycorhiza of Orchids, J. Ramsbottom; The Audibility of the "Puffing" in the Larger Discomycetes, Prof. A. H. R. Buller; and The Sporulating Gonidia of *Evernia prunastri*, Ach., R. Paulson.

PROF. A. D. WALLER, who went by a Handley Page open aeroplane to Brussels on Friday, September 10, has sent home the following notes, which are of interest as giving details of times, etc.:—"Started 2.45 p.m., arrived Brussels 4.40. Misty over London. England very puzzling. Thames distinct. 2.55.—Sea in sight. 3.15.—Left England. 3.20.—Lovely white coast; sun and steamers. Bar. 3000 ft., 95 m.p.h. 3.23.—Marvellous view of both coasts. 3.33.—Arrive France (Calais). 3.47.—Dunkerque. 3.55.—Nieuport and scarred battlefield zone. 4.2.—Dixmude. 4.16.—Ghent. 4.24.—Approaching Brussels. 4.32.—Brussels on horizon (3000 ft.). 4.34.—Are we visible? 4.40.—Gently land."

MR. J. HORNELL produces in the September issue of *Man* new evidence to prove the common origin of the outrigger canoes of Madagascar and East Africa. From these we have evidence of a remarkable case of culture transmission. It is now clear that the dominant Madagascar form is so closely related to that of North Java that we may regard them as identical. It follows, then, that the East African forms are all varieties of the Madagascar model, that the vertical stanchion design of African outriggers is more primitive than the oblique, and that the resemblance of this oblique form of stanchion to certain widely distributed Indonesian types of oblique connecting-joints (modified stanchions) in Bali, the Celebes, and the Moluccas is an instance of convergence and of independent origin.

THE recently established Archæological Department in the dominions of his Exalted Highness the Nizam of Hyderabad is doing excellent service to the study of Indian antiquities. The report of the survey for 1917–18, recently issued, describes the progress made in the inspection of monuments. Every cave of the important Ajanta series is now in good order, and only some minor improvements remain to be made. In co-operation with Sir John Marshall, director of the Imperial Indian Survey, arrangements have been made to bring out an expert from Italy to examine the frescoes and to suggest measures to save them from further decay, while it is contemplated, under a scheme worked out by Sir John Marshall, in consultation with Sir Aurel Stein and M. Foucher, to have them reproduced by the three-colour process. Large collections of inscriptions have been made, and Mr. T. Srinivas, curator of the Hyderabad Museum, was deputed to inspect various other museums in India and to arrange for the exhibition of the Hyderabad collections. It is much to be desired that the other Native States in India, particularly those of Central India and Rajputana, should follow the example thus set by H.H. the Nizam of Hyderabad.

AN address in memory of Pasteur's residence there was delivered at Strasbourg on July 26 by M. Calmette at the Congress of the French Association for the Advancement of Science. The subject was "Ultramicroscopic Micro-organisms." After a description of the salient features connected with many of these organisms, M. Calmette referred to the difficulty of obtaining filter-candles and membranes having a constant and homogeneous texture. Besides their invisibility and filterability, these ultramicroscopic organisms present certain common features. They are all destroyed at a comparatively low temperature and by weak solutions of most disinfectants. On the other hand, they maintain their vitality for a considerable time in pure glycerin. They are infectious only by direct contact or by inoculation, and never by water, air, soil, or fomites. The pathological lesions are also similar, and characterised by cell-"inclusions" and alterations of the cell-nuclei.

A TYPICAL instance of the deplorable methods of the "oologist" is given in the September issue of *British Birds* by Mr. Thomas Lewis, who set himself the task of recording the breeding habits of a colony of lesser terns newly established last year "on the southern part of the Norfolk coast." At one period there were more than forty nests on the beach. Then, on June 19, the colony "was almost completely destroyed by an egg-collector who swept three-fourths of the eggs, most of them far gone in incubation and some actually chipping, from the beach." Instances of this kind are, unhappily, far too common, and while this state of affairs continues the "oologists" can scarcely complain when they are reminded that between "egg-collecting" and scientific ornithology there is a wide gulf. This abominable raid made a complete survey of the breeding habits of this bird impossible; but the author fortunately succeeded in making a series of very valuable observations on the courtship and incubation periods, and in taking a number of remarkably fine photographs which accompany his essay.

THE latest report of the Industrial Fatigue Research Board (No. 8), by Messrs. S. Wyatt and H. C. Weston, is concerned with a preliminary study of some of the problems connected with bobbin-winding. The authors give a description of the conditions prevailing in the bobbin-winding department of a mill where the owners are enlightened enough to appreciate the value of attention to labour-saving devices and to the welfare of the workers. It was found that the conditions of labour were generally satisfactory except for the length of one of the working periods, which was of four and a half hours; such a period is probably too long for monotonous work, and might advisably be broken up by rest-pauses. The marked individual differences in efficiency which were noticed suggest that a more careful selection of the workers would be advantageous. The liability to accidents was very slight and the labour wastage almost negligible, so neither of these could be utilised as data for fatigue. In so far as it was possible to use output as an indication of fatigue, no signs of undue fatigue were evident, although the authors are very careful to emphasise the complex nature of the processes involved, and therefore the difficulty of taking such negative results as final. Although the data obtained do not permit of generalisation, yet it is clear that before confident conclusions on the fatigue resulting from industrial conditions can be reached, very many studies of this nature extending over years must be made in this and other trades, so that an abundance of evidence may be available as a foundation for future work. Such reports are valuable as correctives to the tendency, only too noticeable at the present time, to use science unscientifically.

MR. W. H. DALL, in reviewing "Pliocene and Pleistocene Fossils from Alaska" (U.S. Geol. Surv., Prof. Paper 125-C, 1920), points out that evidence accumulates against the view of a late Cainozoic bridge whereby land animals could cross in the Bering Strait region from Asia to America. The ice of glacial times afforded the only admissible means of communication. The Pliocene fossils of England and Iceland, investigated by Mr. F. W. Harmer, indicate a more free connection than now exists between the Bering Sea and North Atlantic waters.

THE older rocks of Mysore are receiving detailed study from the State Department of Mines and Geology. In the Records of this Department, vol. xvii., p. 67 (1920), Mr. B. Jayaram shows how some of the limestones of Mysore have originated from the alteration of calciferous igneous bands, while many actually replace quartz-felspar rocks of the granite and gneiss series. In Bulletin No. 9 (1920), Mr. P. S. Iyengar treats of the acid rocks of the State in general. As in so many areas, the gneisses have proved to be younger than a schistose series (here the Dharwars), the relations being those already pointed out by Drs. Smeeth and Fermor over a wider field. Mr. Iyengar is firm, and we think thoroughly justified, in his assertion that the Peninsular gneiss is an intrusive rock that has replaced the formation invaded by it.

"THE Use of the Panoramic Camera in Topographical Surveying," by Mr. J. W. Bagley, is a useful publication of the United States Geological Survey (Bulletin 657). In comparison with other methods of survey, the panoramic camera has certain advantages. Its use reduces very considerably the time required to be spent at each station in a plane-table survey. It follows that in the case of reconnaissance surveys a larger number of stations and so greater detail are possible with the help of a panoramic camera than without it. It is also found that with this camera and the plane-table the topographer is better equipped for country of both high and low relief than with the theodolite and plate-camera. Considerations of weight owing to the use of films instead of plates, and of cost as reflected in speedier work, are claimed to show other advantages. Full details are given of the camera and the methods of using it. The largest scale of surveys in which this camera has been used is 1 : 48,000, but this is by no means the limit of its use, which is decided by the degree of accuracy necessary in determining elevations—that is, roughly, by the contour interval. The bulletin also contains some useful notes on the application of photogrammetry to aerial surveys.

MESSRS. NEGRETTI AND ZAMBRA, of Holborn Viaduct, have issued a catalogue and price-list of meteorological instruments. The publication is well illustrated, and a detailed description is given of the several instruments. Each section is prefaced by an historical sketch of the separate branch of observation, which will prove of considerable interest to an observer, and supplies an easy method of valuable information being acquired. The catalogue in our hands is not complete, and is merely a compilation of some sectional lists; the paging shows how much is missing. In the sections for barometer and thermometer the lists do not give the self-recording instruments, although in rainfall and wind the registration instruments are fully dealt with. The section for deep-sea thermometers well illustrates the advantage secured by the long association of the optician with special scientific instruments; these thermometers have been carefully watched and improved by the maker for about half a century. Sunshine instruments of two recognised forms are well described and compared: the "Campbell-Stokes" recorder burns a trace on a time-divided card by the impinging of the sun's rays focussed through a sphere of glass; this system is generally adopted by the Meteorological Office. The other form is the "Jordan" recorder, in which a photograph of the rays of the sun is obtained upon a specially sensitised chart. The catalogue will be forwarded by Messrs. Negretti and Zambra to anyone who may be interested.

ACCORDING to an article by M. Jacques Boyer in *La Nature* for September 4, the aerotechnical institute of the Military Academy at Saint-Cyr has installed a pneumatic tank for experiments on the effects of reduced air-pressure and temperature on the physical powers of aviators. The tank in use up to the present time is 2 metres in diameter and nearly 4 metres long. It is of steel 5 mm. thick, and is insulated thermally by an outside layer of cork 10 cm. thick. Four glazed portholes are provided, through which the officer in charge can observe the aviator under test inside. Air-pumps and an air-refrigeration plant are provided, so that the pressure and temperature of the air in the tank can be varied at will. Oxygen tubes are also available, and the interior and exterior of the tank are in communication by telephone. By the help of this tank Dr. Garsaux has been able to study to what altitude aviators could ascend without losing their skill or injuring themselves, and at what stage of the ascent oxygen should be supplied. These altitudes differ according to the temperament of the aviator, but 6000 metres appears to be the limit for even the best men, and oxygen becomes necessary at 3500 or 4000 metres. Further observations are to be made with a larger tank.

A USEFUL account of the "synthetic" drugs is given by Prof. J. T. Hewitt in a series of Cantor lectures recently published (Journal of the Royal Society of Arts, August 13 and 20). Strictly, the phrase "synthetic drugs," implying as it does that the substances in question are produced artificially and find a use in medicine, would include many fairly simple compounds, such as chloroform; but in practice it is restricted to more or less complex carbon compounds which are either prepared by truly synthetic methods (*e.g.* veronal, phenacetin), or obtained by modifying the structure of naturally occurring compounds through chemical treatment. Thus morphine is converted into codeine (methyl morphine) or into heroin (diacetyl morphine) by appropriate chemical reactions. The lecturer classifies the various products according to their chemical relationships as derivatives of hydrocarbons, alcohols, ketones, and so on, thus obtaining a systematic survey of the various groups. The descriptions of the drugs are supplemented by outlines of the methods of manufacture, and in many instances include notes on the history and literature.

A SIMPLE form of thermo-electric pyrometer, mainly intended for use with electric resistance furnaces, has been placed on the market by the Automatic and Electric Furnaces, Ltd. The thermo-couple is composed of wires of nickel and nickel-chrome alloy, these metals being chosen owing to their resistance to oxidation at temperatures not exceeding 1000° C. The E.M.F. developed by this couple is only about one-half that furnished by a junction of iron and constantan, but is still sufficiently high to enable a pivoted indicator to be used. In order to avoid cold-junction errors, the leads to the indicator consist of the same materials as those of the thermo-couple—a procedure now followed generally in the case of base-metal junctions. In a leaflet issued by the firm an account is given of experiments performed with the view of determining the lag caused by the use of thick wires, and also that due to the use of a protecting sheath. The results show that notable errors may arise by assuming that a sheathed junction closely follows the changing temperature of a furnace, particularly when thick wires are used; and it is concluded that the wires should be as thin as possible—consistent with sufficient strength—and, when permissible, should be used uncovered. Two types of instrument are made: one with the junction unprotected, and intended for use in a clean atmosphere; and the other provided with a silica sheath for use in salt-baths, wires of No. 20 gauge being used in each. Both forms should prove useful for the class of work for which they are intended.

ARRANGED by the Institution of Petroleum Technologists, an interesting lecture on petroleum refining was given on September 8 by Dr. A. E. Dunstan. Crude petroleum is a very complex mixture of substances, which are most conveniently utilised if separated into groups (petrol, "white spirit," kerosene, fuel-oil, and so on) according to their volatility. One object of refining is to effect this separation; a second is to remove impurities, colour, and odour from the products. Probably in the future physico-chemical methods rather than purely chemical treatment will be relied upon for the removal of impurities. Sulphur compounds in particular are mentioned as substances which are adsorbed by passing oil distillates through a column of bauxite or fuller's earth, or, alternatively, by passing the vapour of the oil over heated bauxite. A fact not very generally known is that "toluol" (toluene), so urgently wanted in the war period, occurs naturally in certain varieties of crude petroleum, and "innumerable tons" of it were, indeed, obtained from this source. It is much purer than the toluol extracted from coal-tar, and the lecturer predicts a "future" for the aromatic hydrocarbons yielded by petroleum. Toluol can also be manufactured by "cracking" petroleum—that is, breaking down the more complex molecules into simpler ones by means of heat. This operation, which in its modern forms the lecturer dates back to a patent issued in 1890 to the late Sir Boverton Redwood and Sir James Dewar, is considered to be the most promising way of increasing supplies of petrol from petroleum sources.

AMONG points of interest in the report (Cmd. 881) of the Government Chemist on the work of his department during the past financial year we note that radium was extracted from many thousands of luminous dials, compass-cards, gun-sights, and similar materials made for use during the war. The extraction was complicated by the overwhelming proportion of paint with which the radium was mixed, but practically all was recovered and converted into a form suitable for further use at a comparatively small cost. For the Board of Trade 532 samples of the potash material supplied by Germany to this country were analysed. The samples taken were divided into three portions; one was analysed in Germany, another here, and the third retained in a neutral country for reference in case of dispute. The report, however, does not indicate whether any dispute actually arose. Incidentally, in connection with other samples, a method was worked out for differentiating between sodium chloride and potassium chloride in solid caustic potash. A good deal of work was done on the determination of the nature and proportion of the possible toxic constituents which might be present in water receiving drainage from tarred roads. In the course of this work new and delicate methods for detecting some of the substances were devised. Carbolic acid, for instance, can now be detected and estimated when present in even smaller proportion than one part in a million parts of water. The total number of samples, 368,898, dealt with during the year showed an increase of nearly 80,000 compared with the previous year. The principal increases were due to imported goods, such as wine, sugar, tea, and cocoa; they are indicative of the revival of trade after the return to peace conditions.

WE have just received the Lincolnshire Naturalists' Union Transactions for 1919. The first portion of the volume is devoted to the annual reports of the sectional officers, recording, in most cases, the work which has been done during the past year in their own departments. The report from the botany section is somewhat different; it consists of notes selected from observations on seed-dispersal which have been made during the past fifty years by the sectional president and his colleagues. The methods adopted by birds for the transportation of seeds over long distances are mentioned, and the remainder of the report is given over to a list of the agents and methods by which the seeds of the commoner trees are dispersed. A complete list of the author's observations, which he promises to publish in a future volume, "The Flora of Lincolnshire," will be welcomed by ecologists. The volume also includes lists of marine shells of the Lincolnshire coast by Mr. A. Smith, and of non-marine mollusca of the county, contributed by Mr. J. W. Musham from data obtained from the manuscripts of the late Mr. W. J. Roebuck.

Our Astronomical Column.

ANOTHER QUICKLY MOVING DWARF STAR.—Mr. Innes's zeal in examining pairs of plates with the blink micrometer has been rewarded by the discovery of another very interesting dwarf star with a large proper motion and parallax. The former was detected from plates taken at Sydney, the latter from a series of fourteen plates taken at Johannesburg with the Franklin-Adams lens. The star is of the 12th magnitude; its position for 1920 is R.A. 11h. 12m. 52·39s., S. decl. 57° 8′ 13·1″; the proper motion in R.A. is −2·506″, in decl. +0·973″, total 2·688″ in P.A. 291·2°. The parallax from R.A. measures was found to be 0·350″, that from declination measures 0·324″.

The proper motion of α Centauri is 3·68″ in P.A. 281·4°. That of the present star is sufficiently near this to suggest that it may belong to the same system. Mr. Innes notes that if this were the case its parallax would be about 0·5″. It is not stated whether he took the radial velocity of α Centauri into account; in any case, the observed parallax is sufficiently near to render the assumption of connection tenable.

PROF. BARNARD'S OBSERVATIONS OF NOVA PERSEI.—Prof. Barnard puts the Yerkes refractor to good use in continuing to observe novæ long after they have become too faint for ordinary observers. The Monthly Notices, R.A.S., for June contains his observations of Nova Persei, 1901. Its light is still subject to fluctuations; thus it rose from 13·7 to 12·6 between 1919 November 15 and 18, declining again to 13·7 in the three following days. The mean value in 1920 is 13·48, and the progressive decline appears to have ceased. Unlike some other novæ, its aspect does not now differ from that of an ordinary star, and Prof. Barnard considers that it has returned very closely to its condition before the outburst. Micrometer measures of position appear to show a slight proper motion of the nova relatively to faint adjacent stars, the centennial displacement being 1·08″ in the direction of diminishing R.A. and 2·20″ S.

It is noted that the period required to decline to the pre-nova condition varies in different stars between eight and fifteen years, which is surprisingly short, considering the tremendous character of the outburst.

THE BERGEDORF OBSERVATORY, HAMBURG.—Vol. ii, Nos. 3–5, of the Abhandlungen of this observatory, which has just been issued, contains a useful catalogue of the positions, magnitudes, and colour-indices of the stars in the Pleiades (584 in number) down to mag. 14. The magnitudes were determined by observations with two wedge-photometers. Comparison with Hertzsprung's photographic catalogue shows that the visual magnitudes of the fainter stars are brighter in the mean by 0·7. The colour-indices increase rapidly from mags. 3 to 10, remaining fairly constant after this. Comparison is also made between the number of stars in each half-magnitude interval and the number to be expected in an average region of the same area in galactic latitude 23·7°, using the table of Van Rhijn. For stars brighter than mag. 11 the excess is more than threefold; it then gradually declines, reaching zero at mag. 13½. Another essay discusses the planetary observations made from 1909 to 1920. An interesting round dark spot on Jupiter had the abnormally large rotation period of 9h. 58·13m. from 1920, February 17 to March 18; it then split into two portions, one retaining the same rotation period, while the other had the value 9h. 53·5m., from observations between March 27 and April 1. There is also a study of the contour lines of equal luminosity in the Milky Way (north of decl. −25°). The brightest regions are between γ and β Cygni and in Sagittarius.

Physiological Effects of Insufficient Oxygen Supply.*

By J. BARCROFT, C.B.E., M.A., F.R.S.

PROMINENT among the pathological conditions which claimed attention during the war was that of insufficient oxygen supply to the tissues, or anoxæmia. The statement has been made that "anoxæmia not only stops the machine, but wrecks the machinery." This phrase is so apposite that I shall commence by an inquiry as to the limits within which it is true.

Anything like complete anoxæmia stops the machine with almost incredible rapidity. Though the breath can be held for a time, it must be borne in mind that the lungs normally contain about half a litre of oxygen, and that this will suffice for the body at rest for upwards of two minutes. But get rid of the residual oxygen from the lungs even to the extent possible by the breathing of nitrogen, and you will find that only with difficulty will you endure half a minute. It seems doubtful whether complete absence of oxygen would not bring the brain to an instantaneous standstill. So convincing are the experimental facts to anyone who has tested them for himself that I will not further labour the power of anoxæmia to stop the machine. I will, however, say a word about the assumption which I have made that the machine in this connection is the brain.

It cannot be stated too clearly that anoxæmia in the last resort must affect every organ of the body directly. Stoppage of the oxygen supply is known to bring the perfused heart to a standstill, to cause a cessation of the flow of urine, to produce muscular fatigue, and at last immobility, but from our present point of view these effects seem to me to be out of the picture because the brain is so much the most sensitive to oxygen want.

To what extent does acute anoxæmia in a healthy subject wreck the machinery as well as stop the machine? By acute anoxæmia I mean complete or almost complete deprivation of oxygen which, in the matter of time, is too short to prove fatal. No doubt many data might be quoted of men who have recovered from drowning, etc. Such data are complicated by the fact that anoxæmia has only been a factor in their condition. These data, therefore, have a value in so far as they show that a very great degree of anoxæmia, if acute and of short duration, may be experienced with but little wreckage to the machine. They have but little value in showing that such wreckage is due to the anoxæmia, because the anoxæmia has not been the sole disturbance.

Cases in which the anoxæmia has been uncomplicated are to be found among those who have been exposed to low atmospheric pressures; for instance, balloonists and aviators. Of these quite a considerable number have suffered from oxygen want to the extent of being unconscious for short intervals of time.

No scientific observer has pushed a general condition of anoxæmia either on himself or on his fellows to the extent of complete unconsciousness. The most severe experiments of this nature are those carried out by Dr. Haldane and his colleagues. One experiment in particular demands attention. Dr. Haldane and Dr. Kellas[1] together spent an hour in a chamber in which the air was reduced to between 320 mm. and 295 mm. It is difficult to say how far they were conscious. Clearly each believed the other to be complete master of his own faculties, but it is evident that Dr. Haldane was not so. I gather that he has no recollection of what took place; that whenever he was consulted about the pressure he gave a stereotyped answer which was the same for all questions; and that even with a little more oxygen present he was sufficiently himself to wish to investigate the colour of his lips in the glass, but insufficiently himself to be conscious that he was looking into the back, and not the front, of the mirror. Dr. Kellas, who could make observations, never discovered Dr. Haldane's mental condition, though boxed up with him for an hour, and went on consulting him automatically. A somewhat similar experiment was performed on the other two observers, with results differing only in degree.

Yet the after-effects are summed up in the following sentence: "All four observers suffered somewhat from headache for several hours after these experiments, but there was no nausea or loss of appetite."

Of real importance in this connection are the results of carbon monoxide poisoning. Of these a large number might be cited. Those interested will find some very instructive cases described in a volume entitled "The Investigation of Mine Air," by the late Sir C. Le Neve Foster and Dr. Haldane.[2] The cases in question were those of a number of officials who went to investigate the mine disaster on Snaefell, in the Isle of Man, in May, 1897. Of the five cases cited all suffered some after-effects, by which I mean that by the time the blood was restored sufficiently to its normal condition for the tissues to get the amount of oxygen which they required, the effects of the asphyxia had not passed off, and to this extent the machine suffered.

To sum up, then, what may be said of the permanent damage caused by acute anoxæmia, it seems to me to be as follows: No degree of anoxæmia which produces a less effect than that of complete unconsciousness leaves anything more than the most transient effects; if the anoxæmia be pushed to the point at which the subject is within a measurable distance of death, the results may take days or weeks to get over, but only in the case of elderly or unsound persons is the machine wrecked beyond repair.[3]

Chronic Anoxaemia.

And now to pass to the consideration of what I may call chronic anoxæmia—that is to say, oxygen want which perhaps is not very great in amount, but is of long duration. The most obvious instances of men subject to chronic anoxæmia are the dwellers at high altitudes. In these the anoxæmia does not wreck the machine. On what I may call the average healthy man anoxæmia begins to tell at about 18,000 ft. At lower altitudes no doubt he will have some passing trouble, but it seems to me from my own experience that this altitude is a very critical one. Yet there are mining camps at such heights in South America at which the work of life is carried on. The machine is kept going by a process of compensation, in part carried out by a modification in the chemical properties of the blood, in which both the carbonic acid and the alkali diminish. The result, according to my interpretation of my own observations on the Peak of

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

1 Haldane, Kellas, and Kennaway. *Journal of Physiology*, vol. liii.

2 Foster and Haldane. "The Investigation of Mine Air." (Griffin and Co., 1905.)

3 Since the address was written Dr. Haldane has told me of a number of victims of the same accident who were brought out alive by the search party, but in whose case the machine was wrecked beyond repair. They soon died.

Teneriffe, which appeared to be confirmed by the experiments in a partially vacuous chamber in Copenhagen,[4] was this: The hydrogen-ion concentration of the blood increased slightly, the respiratory centre worked more actively, and the lung became better ventilated with oxygen, with the natural result that the blood became more oxygenated than it would otherwise have been.

The difference which this degree of acclimatisation made was very great. On Monte Rosa in one case 15 mm. of oxygen pressure were gained in the lungs. To put the matter another way, the amount of oxygen in our lungs at the summit was what it would otherwise have been 5000 ft. or 6000 ft. lower down.

The body, then, had fought the anoxæmia and reduced it very much in degree, but at the same time the anoxæmia had in a subtle way done much to stop the powers of the body, for this very acclimatisation is effected at the expense of the ultimate reserve which the body has at its disposal for the purpose of carrying out muscular or other work. The oxygen in the lungs was obtained essentially by breathing at rest as you would normally do when taking some exercise. Clearly, then, if you are partly out of breath before you commence exercise you cannot undertake so much as you otherwise would do. As a friend of mine—who has camped at 23,000 ft., a higher altitude, I believe, than any other man—put it to me: "So great was the effort that we thought twice before we turned over in bed."

One of the interesting problems with regard to chronic anoxæmia is its effect upon the mind. Sir Clement Le Neve Foster's account of himself during CO poisoning shows loss of memory, some degree of intelligence, and a tendency to repeat what is said. The whole train of his symptoms strongly suggests some form of intoxication, and is not dissimilar to that produced by alcoholic excess. Here it may be noted that, so far as isolated nerves are concerned, there is very good evidence that alcohol and want of oxygen produce exactly the same effects, *i.e.* they cause a decrement in the conducting power of the nerve. And herein lies a part of its interest, for pharmacologists of one school, at all events, tell me that the corresponding effects of alcohol are really due to an inhibition of the higher centres of the mind; you can, therefore, conceive of the mental mechanism of self-control being knocked out either because it has not oxygen enough with which to "carry on," or because it is drugged by some poison as a secondary result of the anoxæmia.

To pass now to the results of more chronic anoxæmia, if I were to try to summarise them in a sentence I should say that, just as acute anoxæmia simulates drunkenness, chronic anoxæmia simulates fatigue.

A page in my note-book written at the Alta Vista Hut, at an altitude of 12,000 ft., commences with a scrawl which is crossed out, then "6 Sept.," the word "Sept." is crossed out and "March" is inserted, "March" shares the same fate as "Sept.," and "April," the correct month, is substituted, and so on, more crossings out and corrections. All this you might say with justice is the action of a tired man. The other pages written at lower altitudes do not, however, bear out the idea that I was out of health at the time, and there was no reason for tiredness on that particular day. Another symptom frequently associated with mental fatigue is irritability. Anyone who has experience of high altitudes knows to his cost that life does not run smoothly at 10,000 ft. If the trouble is not with one's own temper, it is with those of one's colleagues; and so it was in many cases of gas poisoning and in the case of aviators. In these subjects the apparent fatigue sometimes passed into a definitely neurasthenic condition. At this point an issue appeared to arise between the partisans of two theories. One camp said that the symptoms were definitely those of anoxæmia, the other that they were due to nerve-strain. As I have indicated later on, it is not clear that these two views are mutually exclusive. It takes two substances to make an oxidation, the oxygen and the oxidised material. If the oxidation does not take place, the cause may lie in the absence of either or of both, in each case with a similar effect. The subject really is not ripe for controversy, but it is amply ripe for research—research in which both the degree of anoxæmia and the symptoms of fatigue are clearly defined.

[4] Hasselbach and Lindhard, quoted by Bainbridge.

So much, then, for the injury to the machine wrought by chronic anoxæmia.

Types of Anoxaemia.

Anoxæmia is by derivation want of oxygen in the blood. Suppose you allow your mind to pass to some much more homely substance than oxygen—such, for instance, as milk—and consider the causes which may conspire to deprive your family of milk, three obvious sources of milk deficiency will occur to you at once: (1) There is not enough milk at the dairy; (2) the milk is watered or otherwise adulterated so that the fluid on sale is not really all milk; and (3) the milkman from that particular dairy does not come down your road.

These three sources of milk deficiency are typical of the types of oxygen deficiency.

The first is insufficient oxygen dispensed to the blood by the lungs. An example of this type of anoxæmia is mountain-sickness. The characteristic of it is insufficient *pressure* of oxygen in the blood. In mountain-sickness the insufficiency of pressure in the blood is due to insufficient pressure in the air. But this type of anoxæmia may be due to other causes. In such cases, either caused by obstruction, by shallow respiration, or by the presence of fluid in the alveoli, the blood leaving the affected areas will contain considerable quantities of reduced hæmoglobin. This will mix with blood from unaffected areas which is about 95 per cent. saturated. The oxygen will then be shared round equally among the corpuscles of the mixed blood, and if the resultant is only 85–90 per cent. saturated the pressure of oxygen will only be about half the normal, and, as I said, deficiency of oxygen pressure is the characteristic of this type of anoxæmia.

The second type involves no want of oxygen pressure in the arterial blood; it is comparable to the watered milk. The deficiency is really in the quality of the blood, and not in the quantity of oxygen to which the blood has access. The most obvious example is anæmia, in which the blood contains too low a percentage of hæmoglobin, and because there is too little hæmoglobin to carry the oxygen, too little oxygen is carried. Anæmia is, however, only one example of this type of anoxæmia. The hæmoglobin may be useless for the purpose of oxygen transport; it may be turned in part into methæmoglobin, as in several diseases, *e.g.* among workers in the manufacture of some chemicals, and in some forms of dysentery contracted in tropical climates, or it may be monopolised by carbon monoxide, as in mine-air.

Thirdly, the blood may have access to sufficient oxygen and may contain sufficient functional hæmoglobin, but owing to transport trouble it may not be circulated in sufficient quantities to the tissues. The quantity of oxygen which reaches the tissue in unit time is too small. Literally, according to the strict derivation of the word "anoxæmia," the third type should perhaps be excluded from the category of conditions covered by that word, but as the result is oxygen starvation in the tissues it will be convenient to include it.

The obvious types of anoxæmia may therefore be classified in some such scheme as the following:

ANOXÆMIA.

1. *Anoxic Type.*	2. *Anaemic Type.*	3. *Stagnant Type.*
The pressure of oxygen in the blood is too low.	The quantity of functional hæmoglobin is too small.	The blood is normal, but is supplied to the tissues in insufficient quantities.
The hæmoglobin is not saturated to the normal extent.	The oxygen pressure is normal.	Examples:
The blood is dark.	The blood is normal in colour.	1. Secondary result of histamine shock.
Examples:	Examples	2. Hæmorrhage.
1. Rare atmospheres.	1. Too little hæmoglobin.	3. Back pressure.
2. Areas of lung partially unventilated.	2. CO hæmoglobin.	
3. Fluid or fibrin on surface of cells.	3. Methæmoglobin.	

Anoxic anoxæmia is essentially a general as opposed to a local condition. Not only is the pressure of oxygen in the blood too low, but the lowness of the pressure, and not the deficiency in the quantity, is the cause of the symptoms observed.

The workers on Pike's Peak, for instance, emphasised the fact that the increase of red-blood corpuscles during their residence at 14,000 ft. was due to deficient oxygen pressure. No doubt they were right, but the point was rather taken from their argument by their assertion in another part of the paper that the oxygen pressure in their arterial blood was anything up to about 100 mm. of mercury. Let me, therefore, take my own case, in which the alveolar pressures are known to be an index of the oxygen pressures in the arterial blood. I will compare my condition on two occasions, the point being that on these two occasions the quantities of oxygen united with the hæmoglobin were as nearly as may be the same, whilst the pressures were widely different.

As I sit here the hæmoglobin value of my blood is 96–97, which corresponds to an oxygen capacity of 0·178 c.c. of O_2 per c.c. of blood. In the oxygen chamber on the last day of my experiment, to which I refer later,[5] the oxygen capacity of my blood was 0·201 c.c. Assuming the blood to be 95 per cent. saturated now and 84 per cent. saturated then, the actual quantity of oxygen in the blood on the two occasions would be:

Oxygen capacity.	Percentage saturation.	Oxygen content.
0·178	95	0·169
0·201	84	0·169

Here I am in my usual health. In the chamber I vomited; my pulse was 86, it is now 56; my head ached in a most distressing fashion; it was with the utmost difficulty that I could carry out routine gas analyses, and when doing so the only objects which I saw distinctly were those on which my attention was concentrated.

In the anoxic type of anoxæmia there may then be quite a sufficient quantity of oxygen in the blood, but a sufficient quantity does not avail in the face of an insufficient pressure. Indeed, as I shall show presently, the anoxic type of anoxæmia is the most serious. We are, therefore, confronted with something of a paradox in that the most severe type of anoxæmia is one in which there is not necessarily an insufficient quantity of oxygen in the blood at all.

[5] Barcroft, Cooke, Hartridge, Parsons, and Parsons. *Journal of Physiology*, vol. liii., p. 451, 1920.

It is interesting and not uninstructive to try to calculate the degree to which the tissues are prejudiced by being subjected to various types of anoxæmia. Let us suppose that we have a piece of tissue—muscle, for instance—which normally is under the following conditions:

(*a*) One cubic centimetre of blood per minute runs through it.

(*b*) The total oxygen capacity of this blood is 0·188 c.c. of oxygen per c.c. of blood.

(*c*) The percentage saturation is 97.

(*d*) The oxygen pressure is 100 mm.

(*e*) The oxygen used is 0·059 c.c.

(*f*) The oxygen pressure in the tissues is half of that in the veins, in this case 19 mm.

My colleague, Mr. F. J. Roughton, has calculated the amount of oxygen which would penetrate this tissue from the blood in each type of anoxæmia, if the oxygen which reached it in the blood was reduced to 66 per cent. of the quantity stated above.

Measurement of Anoxaemia.

In the study of all physical processes there comes a point, and that very early, when it becomes necessary to compare them one with another to establish some sort of numerical standard and have some sort of quantitative measurements. The study of anoxæmia has reached that point. By what scale are we to measure oxygen want?

Let us take the anoxic type first. There are two scales which might be applied to it, both concerning the arterial blood; the one is the oxygen pressure in it, the other is the consequent percentage of the hæmoglobin which is oxyhæmoglobin. The important thing is that there should be as little reduced hæmoglobin as possible. The more reduced hæmoglobin there is present, the less saturated is the blood; or, as the American authors say, the more *un*saturated is the blood. They emphasise the fact that it is the quantity of *reduced* hæmoglobin that is the index of the anoxic condition. They speak not of the percentage saturation, but of the percentage of unsaturation. A blood which would ordinarily be called 85 per cent. saturated they speak of as 15 per cent. unsaturated.

Anoxic anoxæmia, in many cases of lung affection, should be measured by the direct method of arterial puncture introduced by Stadie,[6] for the simple reason that the relation between the alveolar air and the arterial blood is quite unknown. Such, for instance, are cases of many lung lesions of pneumonia in which the lung may be functioning only in parts, of pneumothorax, of pleural effusions, of emphysema, of multiple pulmonary embolism, in phases of which the arterial blood has been found experimentally to be unsaturated. In addition to these definite lung lesions there is another type of case on which great stress has been laid by Haldane, Meakins, and Priestley, namely, cases of shallow respiration.[7] A thorough investigation of the arterial blood is such cases is urgently necessary. Indeed, in all cases in which it is practicable, the method of arterial puncture is desirable. But in the cases of many normal persons—as, for instance, those of airmen at different altitudes—alveolar-air determinations would give a useful index.

The anæmic type of anoxæmia is gauged by the quantity of *oxy*hæmoglobin in the blood. In the case of simple anæmias this is measured by the scale in which the normal man counts as 100, and the hæmoglobin in the anæmic individual is expressed as a percentage of this. This method has been stan-

[6] Stadie. *Journal of Experimental Medicine*, vol. xxx., p. 215, 1919.,

[7] Haldane, Meakins, and Priestley. *Journal o Physiology*, vol. lii. p. 420, 1918–19.

dardised carefully by Haldane, and we now know that the man who shows 100 on the scale has an oxygen capacity of 0·185 c.c. of oxygen for every c.c. of blood. We can, therefore, in cases of carboxyhæmoglobin or methæmoglobin poisoning, express the absolute amount of oxyhæmoglobin pressure either by stating the oxygen capacity and so getting an absolute measurement, or in relative units by dividing one hundred times the oxygen capacity by 0·185, and thus getting a figure on the ordinary hæmoglobin metre scale.

The Mechanism of Anoxaemia.

Perhaps the most difficult phase of the discussion is that of how anoxæmia produces its baneful results. Before you discuss whether a certain effect is due to cause A or cause B, be clear in your own mind that A and B are mutually exclusive.

Let me take an example and suppose

(1) That the energy of muscular contraction in the long run depends in some way on the oxidation of sugar;

(2) That in the absence of an adequate supply of oxygen the reaction $C_6H_{12}O_6+6O_2=6CO_2+6H_2O$ cannot take place in its entirety;

(3) That in such circumstances some lactic acid is formed as well as carbonic acid;

(4) That the hydrogen-ion concentration of the blood rises and the total ventilation increases. On what lines are you to discuss whether the increased ventilation is due to "acidosis," by which is meant in this connection the increased hydrogen-ion concentration of the blood, or to "anoxæmia"? Clearly not on the lines that it must be due to one or other, for in the above instance anoxæmia and acidosis are, to some extent, dependent variables.

I have chosen the above case because measurements have been made throughout which make the various assumptions fairly certain, and tell us pretty clearly in what sort of chain to string up the events, what is cause and what is effect. Clearly it would be ridiculous to start a discussion as to whether the breathlessness was due to "acidosis" or "anoxæmia." Each has its place in the chain of events, but I have heard discussions of whether other phenomena of a more obscure nature were due to oxygen want or to acidosis. Such discussions tend to no useful end.

Nor is this the only problem with regard to oxygen want concerning which my warning is needed. Oxygen want may act immediately in at least two ways:

(1) In virtue of absence of oxygen some oxidation which otherwise might take place does not do so, and therefore something which might otherwise happen may not happen. For instance, it may be conceived that the respiratory centre can go through the rhythmic changes of its activity only as the result of the oxidation of its own substance.

(2) A deficient supply of oxygen may produce, not the negation of a chemical action, but an altered chemical action which in its turn produces toxic products that have a secondary effect on such an organism as the respiratory centre.

Now these effects are not mutually exclusive. In the same category are many arguments about whether accumulations of carbonic acid act specifically as such or merely produce an effect in virtue of their effect on the hydrogen-ion concentration. Here again the two points of view are not, strictly speaking, alternatives, and, in some cases at all events, both actions seem to go on at the same time.

It will be evident that in any balanced action in which CO_2 is produced its accumulation will tend to retard the reaction; but, on the other hand, the same accumulation may very likely raise the hydrogen-ion concentration, and in that way produce an effect.

It is rather fashionable at present to say that "the whole question of acidosis and anoxæmia is in a hopeless muddle." To this I answer that if it is in a muddle, I believe the reason to be largely because schools of thought have rallied round words and have taken sides under the impression that they have no common ground. The "muddle," in so far as it exists, is not, I think, by any means hopeless; but I grant freely enough that we are rather at the commencement than at the end of the subject; that much thought and much research must be given, first, in getting accurate data, and, secondly, on relating cause and effect, before the whole subject will seem simple. No effort should be spared to replace indirect by direct measurements. My own inference with regard to changes of the reaction of the blood, based on interpretations of the dissociation curve, should be checked by actual hydrogen-ion measurements, as has been done by Hasselbach and is being done by Donegan and Parsons.[8] Meakins also is, I think, doing great work by actually testing the assumptions made by Haldane, Priestley, and himself as regards the oxygen in arterial blood.

The Compensations for Anoxaemia.

For the anoxic type of anoxæmia two forms of compensation at once suggest themselves. The one is increased hæmoglobin in the blood; the other is increased blood-flow through the tissues. Let us, along the lines of the calculations already made, endeavour to ascertain how far these two types of compensation will really help. To go back to the extreme anoxic case already cited, in which the hæmoglobin was 66 per cent. saturated, let us, first, see what can be accomplished by an increase of the hæmoglobin value of the blood. Such an increase takes place, of course, at high altitudes. Let us suppose that the increase is on the same grand scale as the anoxæmia, and that it is sufficient to restore the actual quantity of oxygen in 1 c.c. of blood to the normal. This, of course, means a rise in the hæmoglobin value of the blood from 100 to 150 on the Gowers scale. Yet even so great an increase in the hæmoglobin will increase the oxygen taken up in the capillary from each c.c. of blood only from 0·031 to 0·036 c.c., and will, therefore, leave it far short of the 0·06 c.c. which every cubic centimetre of normal blood was giving to the tissue. So much, then, for increased hæmoglobin. It gives a little, but only a little, respite. Let us turn, therefore, to increased blood-flow.

In the stagnant type of anoxæmia the principal change which is seen to take place is an increase in the quantity of hæmoglobin per cubic millimetre of blood.

This increase is secondary to a loss of water in the tissues, the result in some cases, as appears from the work of Dale, Richards, and Laidlaw,[9] of a formation of histamine in their cells. Whether this increase of hæmoglobin is to be regarded as merely an accidental occurrence or as a compensation is difficult to decide at present. Roughton's calculations rather surprised us by indicating that increased hæmoglobin acted less efficiently as a compensatory mechanism than we had expected. This conclusion may have been due to the inaccuracy of our assumptions. I must therefore remind you that much experimental evidence is required before the assump-

8 Donegan and Parsons. *Journal of Physiology*, vol. lii., p. 315, 1919.
9 Dale and Richards. *Journal of Physiology*, vol. lii., p. 110, 1919. Dale and Laidlaw. *Ibid.*, p. 355.

tions which are made above are anything but assumptions. But so far as the evidence available at the present time can teach any lesson, that lesson is this: The only way of dealing satisfactorily with the anoxic type of anoxæmia is to abolish it by in some way supplying the blood with oxygen at a pressure sufficient to saturate it to the normal level.

It has been maintained strenuously by the Oxford school of physiologists that Nature actually did this; that when the partial pressure in the air-cells of the lung was low, the cellular covering of that organ could clutch at the oxygen and force it into the blood at an unnatural pressure, creating a sort of forced draught. This theory, as a theory, has much to recommend it. I am sorry to say, however, that I cannot agree with it on the present evidence. I will only make a passing allusion to the experiment which I performed in order to test the theory, living for six days in a glass respiration-chamber in which the partial pressure of oxygen was gradually reduced until it was at its lowest—about 45 mm. Such a pressure, if the lung was incapable of creating what I have termed a forced draught, would mean an oxygen pressure of 38–40 mm. of mercury in the blood, a change sufficient to make the arterial blood quite dark in colour, whereas, did any considerable forced draught exist, the blood in the arteries would be quite bright in colour. Could we but see the blood in the arteries, its appearance alone would almost give the answer as to whether or no oxygen was forced, or, in technical language, secreted, through the lung-wall. And, of course, we could see the blood in the arteries by the simple process of cutting one of them open and shedding a little into a closed glass tube. To the surgeon this is not a difficult matter, and it was, of course, done. The event showed that the blood was dark, and the most careful analyses failed to discover any evidence that the body can force oxygen into the blood in order to compensate for a deficiency of that gas in the air.

Yet the body is not quite powerless. It can, by breathing more deeply, by increasing the ventilation of the lungs, bring the pressure of oxygen in the air-cells closer to that in the atmosphere breathed than would otherwise be the case. I said just now that the oxygen in my lungs dropped to a minimal pressure of 48 mm.; but it did not remain at that level. When I bestirred myself a little it rose, as the result of increased ventilation of the lung, to 56 mm., and at one time, when I was breathing through valves, it reached 68 mm. Nature will do something, but what Nature does not do should be done by artifice. Exploration of the condition of the arterial blood is only in its infancy, yet many cases have been recorded in which in illness the arterial blood has lacked oxygen as much as, or more than, my own did in the respiration-chamber when I was lying on the last day, with occasional vomiting, racked with headache, and at times able to see clearly only as an effort of concentration. A sick man, if his blood is as anoxic as mine was, cannot be expected to fare better as the result, and so he may be expected to have all my troubles in addition to the graver ones which are, perhaps, attributable to some toxic cause. Can he be spared the anoxæmia? The result of our calculations so far points to the fact that the efficient way of combating the anoxic condition is to give oxygen. During the war it was given with success in the field in cases of gas poisoning, and also special wards were formed on a small scale in this country in which the level of oxygen in the atmosphere was kept up to about 40 per cent., with great benefit to a large percentage of the cases. The practice then inaugurated is being tested at Guy's Hospital by Dr. Hunt, who administered the treatment during the war.

Nor are the advantages of oxygen respiration confined to pathological cases. One of the most direct victims of anoxic anoxæmia is the airman who flies at great heights. Everything in this paper tends to show that to counteract the loss of oxygen which he sustains at high altitudes there is but one policy, namely, to provide him with an oxygen equipment which is at once as light and as efficient as possible—a consummation for which Dr. Haldane has striven unremittingly. And here I come to the personal note on which I should like to conclude. In the pages which I have read views have been expressed which differ from those which he holds in matters of detail—perhaps in matters of important detail. But Dr. Haldane's teaching transcends mere detail. He has always taught that the physiology of to-day is the medicine of to-morrow. The more gladly, therefore, do I take this opportunity of saying how much I owe, and how much I think medicine owes and will owe, to the inspiration of Dr. Haldane's teaching.

The University Problem in London.

A REUNION of the Old Students' Association of the Royal College of Science was held on Tuesday evening, September 14, at the Imperial College Union, South Kensington. The president (Sir Richard Gregory) was in the chair, and the principal feature was an address by Prof. H. E. Armstrong entitled "Pre-Kensington History of the Royal College of Science and the University Problem in London." The address was devoted largely to an autobiographical sketch of Prof. Armstrong's early experiences at the Royal College of Science, dating back to the summer term of 1865, when he became a student of its forerunner, the Royal College of Chemistry, then situate in Oxford Street. Prof. Armstrong's reminiscences of Hofmann, McLeod, Tyndall, Huxley, Frankland, and others were all delightful to listen to, but especially of the first-named did he evidently cherish an affectionate memory. A discussion followed, in which the chairman, Dr. M. O. Forster, Prof. Whitehead, Prof. Morgan, Prof. E. W. Skeats, Dr. G. T. Moody, and Mr. S. W. Hunt took part. Some remarks of the lecturer referring to examinations seemed to be regarded as a polemic against this feature of university life, and called forth a certain amount of timid apology and some vigorous defence. Prof. Armstrong, briefly replying, explained that he did not object to examinations, but to the London system; what he was anxious to see was a series of institutions established in London which would make education effective. It was for each one to consider what was the best system, but so long as each school attempted to do everything there could not be success. The part of the address referring to this subject is subjoined.

I have now fifty years' direct experience of the London University system. Throughout this period the talk has ever been of examinations, never of learning—London has been without educational ideals. Under the system methods of teaching have been hopelessly stereotyped; the teachers have neither been free to teach nor the students to learn. At no time has the character of the training been under discussion; the one concern has been to maintain the "standard" of the examinations—as if there could be a fixed standard when examiners are always being changed and knowledge grows from day to day. No two individuals are mentally comparable. In the degree examinations no allowance has been made for the student's proclivities and choice of profession; for example, whether chemist or physicist, the candidate has been forced to reach the same standard in both chemistry and physics. There may have been a well-meant intention to lay a broad foundation, but there has been no understanding of student-nature.

Philosophers insist that the main office of education is to develop and foster the altruistic spirit—a belief in truth, in goodness, in beauty, in each for its own sake; so we should believe in education primarily for its own sake, as the source of our happiness, not mainly because it brings pecuniary advantage or preferment. From this point of view the present university examination system is one of the most selfish, the most corrupting, ever created; it encourages love of show and advertisement, the spirit of competition and commercialism. Unfortunately, the vested interests which its practice has created are numerous and powerful; the underground influence these will exert in deprecation of change cannot fail to be great. Teachers themselves will be loth to abandon it, for, being paid starvation wages, the pittance they gain from examinations is of consequence.

The Germans alone have grasped the problem of university education. At the degree examination they have only required proof of competent knowledge of the student's chosen subject, together with general knowledge of a couple of cognate subjects which he has been allowed to select from a list. Whatever stones we may throw at German morals, we cannot but admit that their system has given results in practice, whilst ours has not. The time is coming when we shall be forced to allow "self-determination" in higher education as well as in the case of small nations.

Intellectuals are not only a peculiar people, but a mixture of peculiar classes of definitely peculiar people.

We have long ceased to believe in the disciplinary value of this or that subject, and are gradually, but all too slowly, coming to admit that allowance must be made for the extraordinary variation in the ability and intellectual proclivities of individual students. I have given particulars of my own case, but I know of many similar experiences among friends and students whom I have had under constant observation. I know several men who have greatly distinguished themselves as students in subjects which they have thrown entirely to the winds in later life, the study of which has been without the least influence on their mental development. Being acquisitive and conscientious workers, they set themselves to an allotted task and succeeded in it, but the time spent in the study was wasted. Many able students have the advocate's faculty of getting up a case for the time being and as quickly forgetting it when over.

I am satisfied, from long study of the two classes, that the average engineering student and the average chemical or physical student are of two quite different types of mind. The engineering student shies at chemistry and physics, and rarely acquires sympathy with either subject, not because he does not want to learn them, but because their method makes no appeal to his intelligence—the habit of mind of the engineer being constructive, whilst that of the chemist and physicist is analytical and introspective. The engineer usually does work at the request of others; when he realises what is wanted, as a rule he can meet requirements. He is prepared to learn how to use electrical machinery, but he does not want to know much about electricity.

Chemical engineers are being much asked for. We may raise a few by striving to teach engineers to be chemists; a larger proportion, perhaps, by teaching chemists engineering, because many chemists are constructive in their outlook as well as analytical, but in neither case will the hybrid be really competent in both subjects. If we are wise we shall follow the German example and manacle chemist with engineer and attune the two to work in sympathetic vibration. The engineer has been spoilt in this country, and needs to be put in his place. He has far too much assurance, and is believed in just because he does things which make a public show; really, he is not anything like so big as he would have us believe, and is largely dependent on chemists and others who do the work he but plans. All this is by way of emphasising my point that special kinds of university education must be provided to meet the wants of specific classes—that there is no one royal road to effective knowledge. The man who masters a subject he has feeling for does so intuitively—it is in him to understand. When we complain, too often unjustly, of the failure of students in examinations and that they have learnt little or nothing, assuming that it is because they have been inattentive or not applied themselves, we do not realise how difficult it is for most to learn.

To be specific, I am of the opinion that the Imperial College must be autonomous. To be efficient its courses must be most carefully adjusted to suit the special peculiarities of its students, and their ability must be rated by those who can follow and appreciate their work. Only their teachers can do this. As Sir W. H. Bragg and Prof. Starling stated in their striking letter to the *Times* of December 22 last: "The whole development of university education in London is impeded at every step by the subjection of the colleges to an examining body which is incompetent by constitution to deal with academic affairs. Academic freedom is essential to progress." The teachers must always be in advance of the examiners, who necessarily work to a published programme; if they be made subservient, all sense of initiative disappears, and their efforts to improve and advance are stultified and sterilised; moreover, but few students have the desire to work at subjects which do not pay in the examinations, nor can they be blamed in view of the intensity of the struggle for existence. True ideals are only possible under a free system.

But I would not merely free the Imperial College and continue it as it is; I would limit its functions, because I am sure that it does not, and cannot in the future, do all that it now attempts, and apparently desires, to do. It attempts to provide both for physical and biological science, but the requirements of these two branches of knowledge are totally distinct, to be met only by distinct staffs. Devotion to physical science involves and requires a mathematical habit of mind; biological science is definitely non-mathematical in its tendencies; the two habits are very rarely conjoined. Past discussions on heredity afford a striking illustration of this duality. Though a chemist, I happen always to have had marked biological leanings. In studying my colleagues in science, nothing has struck me more than the slight appeal biology makes to those on the physical side. Naturalists there are, not a few; but these, as a rule, are not developed scientific workers. The professed devotee to physical science is rarely a naturalist; even mineralogists are not often found among them. Biochemistry has been to the fore of late years, but the so-called biochemists are mostly just ordinary chemists in disguise, working with materials derived from animal or vegetable substance. The number who have distinct biological feeling is very small—probably to be counted on the hand.

To meet the entirely special requirements of biology, I would constitute University College an Imperial College of Biological Science and Technology. I would interchange the biological staff of the college at South Kensington and that on the physical side of the college in Gower Street. The Rockefeller gift has rendered this change one that is now easier to make and more desirable than it ever was. If effected, it would at least be a great step towards the solution of the pressing problem of preliminary medical education in London.

To deal with the third of the London colleges, King's, its science may well be handed over to the two colleges I have suggested. Let it, then, become a great independent Imperial College of Arts and Economics.

The three colleges should be federated in one Imperial University of London. The objective of the tripartite organisation would be to make education in each of the three departments effective, which it never will be so long as three conflicting colleges exist in which the same subjects are taught without any provision for the mental dissimilarities to which I have insistently referred.

London and the provincial universities suffer from the disability that they afford no opportunity for social training. Cambridge and Oxford necessarily rank before them in this respect, and the attractiveness of the two ancient Universities cannot be countered, as it largely depends on time and tradition. But social training is of the utmost importance, and the attempt must be made to provide it in London.

> The man of men who knoweth men, the Man of men is he!
> His army is the human race and every foe must flee.

If the Arts College were established on a country site, such as that at Kenwood, space might be found for attractive residential quarters as well as playing fields, and on these latter students from the three colleges might well unite their forces; but it is clear that hostels will be required both at Kensington and in Gower Street. If these had gymnasia and debating halls, students would be much brought together. But even if such provision be made, Cambridge and Oxford, on account of their social advantages, will always tend to attract the intelligence of the nation, and the teaching centres in London and the provinces will suffer accordingly. The only way of competing open to the latter is that each should become so prominent in some special subject that, of necessity, those who wish to be proficient in the subject will be attracted.

Each of the three colleges would award its own degrees. Sir Philip Magnus, who is a conservative advocate of the present system, would have the colleges grant a diploma, leaving the degree to be awarded by the University. In a letter to the *Times* of June 11 last he remarks: "In the interests of university education it is surely wiser to maintain the distinction between a college diploma and a university degree. They do not, and should not, connote the same qualifications, and for that reason, if for no other, they should remain distinct."

As a matter of fact, in London the diploma has connoted the same qualification as the degree; the course of training at the Imperial College is the same, whether or no the student take the university degree; at most he is compelled to "cram" some subject or special section of a subject not in the diploma course. Such learning, we know, is almost always forgotten after the examination is over.

The degree-hunger is upon us; students demand degrees, and will have them at any cost. The question is: Shall it be at the cost of their moral outlook and of much wasted time, or in recognition of honest, thorough work? Scientific workers desire to be designated by some distinct title; even the American puts aside his Republican feeling and is pleased to be called "doctor."

Diploma is not an English word; it is suggestive of exhibitions and a framed illuminated certificate rather than of the university. You cannot call a man "Diplomat so and so"—the more so as diplomacy now ranks as a doubtful profession. When Sir Philip Magnus says that diploma and degree do not connote the same qualifications, he has unconsciously in his mind the idea that the University course includes "arts" training, and counts for culture; but the diploma-holder is not required to pass in any literary subject when a candidate for the degree.

Sir Philip Magnus, I know, fears the neglect of literary study in a college such as the Imperial College, though he has nothing to say against the neglect of science in an arts course. Those who live in houses built of the thinnest of glass should not speak too loudly. This view is based on a fallacy, on the assumption that scientific workers in general are weak on the literary side, especially in expressing themselves. They are no weaker than their literary brethren; as a rule, both come to the University with the same literary preparation; neither has been taught the art of writing. The art of reading is acquired during youth; literary foundations should be laid during the school-years, and, if well and truly laid, will be built upon afterwards. The love of books can come only as a free gift, through quiet suggestion and opportunity and leisure to read. The university is the place for special study and self-development—the place where chances sacrificed at school are often recovered; but as the future student of science in an efficient college will be required to record the work he does in accurate and logical terms and to be concise in his statements, he will, in fact, receive definite literary training, maybe in advance of his literary contemporary.

Under a federal scheme such as I have outlined a student would be free to attend courses at a college not his own, and would have credit for such outside attendance. He would be as broad as his heredity would permit.

My proposals may seem to be revolutionary, but we need a revolution in education to make it effective. Merely to mend and patch the old machine will not help us; new ideals should prevail. We must determine to go forward, putting self in the background and thinking only of national interests. Somewhere a leader must be found: "to see and dare and decide; to be a fixed pillar in the welter of uncertainty." It is our imperative duty to "shut together the clasps of resolve."

> Dreading retreat, dreading advance to make,
> Round we revolve, like to the wounded snake.

At this critical hour there can be no better call to all than that of the single line in the biting, short poem "To England," in a recent issue (August 26) of the *Times*:

> Show what you are, *of high and generous race.*

The Exmoor Earthquake of September 10.

EARLY in the morning of Friday, September 10, three slight earthquakes were felt in North Devon in the district between Morte Bay and Exmoor Forest. The first occurred at about 12.15 a.m., and this was followed about an hour later by two slighter shocks separated by an interval of ten minutes. Though it is reported that part of a chimney was dislodged at East Down, and that the light at Bull Point lighthouse was extinguished, it is doubtful if the intensity of the shock at any place exceeded the degree 4 of the Rossi-Forel scale.

The chief interest of the earthquake lies in its connection with a similar, but slightly stronger, shock which occurred on January 23, 1894 (*Geol. Mag.*, vol. iii., 1896, pp. 553-56). This earthquake disturbed an area 30 miles long, extending from Ilfracombe to about 2 miles east of Dulverton, and 16½ miles wide, the whole area containing about 389 square miles. The centre of the inner isoseismal (intensity 4) was half a mile south-west of Simonsbath. From the dimensions and relative positions of the isoseismal lines it was inferred that the earthquake was due to a fault passing close to Simonsbath, running in the direction E. 22° S., and hading to the south—a position which agrees almost exactly with that of the northern boundary fault of the Morte Slates. The length of the fault-displacement was probably about 10 miles.

From the accounts so far received it appears that the disturbed area of the recent earthquake is shifted to the west. It is about 22 miles long, 13½ miles wide, and contains about 230 square miles. The centre lies half a mile north of East Down and a mile south of the northern boundary fault of the Morte Slates—that is, on its downthrow side. The length of the seismic focus was about 8 miles, with its centre 10 miles west of that of the earthquake of 1894. The points of interest are (1) that, as is so often the case in British earthquakes, the epicentre migrated to the west, and (2) that the lengths of the two foci and the distance between their centres were roughly equal to that which separates the epicentres of British twin earthquakes. C. DAVISON.

Aids to Forecasting.[1]

A LONG-FELT want of the weather forecaster has been a methodical classification of weather types associated with the various weather conditions which present themselves. The weather-chart commonly offers a picture familiar enough to the forecaster, but there is much connected with the movement and development which depends upon the bounding conditions. A low-pressure system or depression when appearing off our south-west coasts may have a clear path to the north-eastward, the high-pressure system in its front giving way to its progress. On the other hand, the high-pressure system or anticyclone may be well established and may maintain its ground, thus compelling the advancing disturbance to adapt its track to the situation—a feature of no uncommon occurrence, but one offering considerable difficulty to the work of the forecaster.

Lt.-Col. Gold has made a good attempt to classify the different types of weather which present themselves, and it seems an advance on any previous effort in this direction. The memoir is not hampered by mathematics, and is the outcome of a classification and analysis made by the Meteorological Section, R.E., in France during the late war. It is an effort to supply the forecaster when in doubt with reference to some previous situations of a similar character, so that he may see what developments occurred.

Forecasting is admitted to be a matter of experience which is not always very lengthy. Fifteen types and sub-types have been selected, and are graphically shown in the diagrams. The controlling feature in the type is the distribution of atmospheric pressure, and especially the position of the anticyclone. The Daily Weather Charts for fourteen years, 1905-18, have been analysed according to these types and are classified by months. The results are given in tables, and the forecaster, having drawn his chart, can see to which type it most nearly corresponds, and then look up the dates in the corresponding month on which the type previously occurred. On reference to the Daily Weather Charts for these days he will be able to trace the later developments.

The type-frequency is given in a table for the several months on the totals for fourteen years, which shows clearly the preference of different types for the separate seasons. The essential weather features associated with each type are clearly set out, and relate primarily to the winds and weather of North-East France and Flanders, although applying also to the conditions over the British Isles. C. H.

[1] "Types of Pressure Distribution, with Notes and Tables for the Fourteen Years 1905-18." By E. Gold. Meteorological Office. Geophysical Memoirs, No. 16. (Published by the Air Ministry.) Price 2s. 6d.

American Work in Genetics.

THE increasing intricacy of genetic problems and the volume of contributions from American investigators are notable features of present-day biology. Selection of a few recent papers will indicate the way in which genetic experiment is permeating many fields of biological research.

Dr. F. B. Sumner is continuing his studies of the Californian races of the deer-mouse, *Peromyscus maniculatus*, and in a paper on geographic variation and Mendelian inheritance (*Journ. Exptl. Zool.*, vol. xxx., No. 3) reaches conclusions which, if substantiated by further work, will be of great interest. The subspecies studied are *rubidus*, which occurs near the coast northwards from San Francisco Bay; *Gambeli*, a coast-form south of the bay; and *sonoriensis*, a desert form from the interior of Southern California. Wild mice were trapped from eight stations within these areas, and caged mice are also being extensively bred. Significant racial differences are found in respect to mean length of skull, ear, foot, pelvis, femur, and tail, width of the dorsal tail stripe, colour of pelage, pigmentation of feet, and number of tail vertebræ. Local differences also occur within the range of the same sub-species. Mutations have been described which show Mendelian inheritance, but in hybrids between geographic races it is claimed that the result is a blend, with very little evidence of later segregation.

Among the numerous genetic studies of extra bristles in Drosophila, that of MacDowell has been most extensive. In two of his latest papers (*Journ. Exptl. Zool.*, vol. xxiii., No. 1, and vol. xxx., No. 4) he has further analysed the effects of selection on the number of bristles. After selection for a high number through several generations, reverse selection was found to be impossible, except after crossing with the normal type, which has four bristles. One main factor determines a monohybrid ratio in crosses with normal flies, but there is no dominance in the ordinary sense, and there are additional genetic differences between flies having extra bristles. Studies by Payne indicate the presence of one bristle factor in the sex chromosome and another in the third group, but the exact relation of these to the increase in number of bristles has not been determined. The environment also influences the number of bristles which appear. In MacDowell's experiments forty-nine generations were bred, and it was found that in a uniform environment selection had no effect after the thirteenth generation; statistical methods show that selection failed to shift the modal condition, and no mutations occurred during the experiments.

In a study of the effects of alcohol on white rats, the same author (Proc. Nat. Acad. Sci., vol. iii., p. 577) finds that alcoholised rats showed a considerable falling off in the weight of their offspring, and a still greater loss in fecundity. Twenty-nine pairs of normal rats produced three hundred young in the same time that thirty alcoholised pairs produced one hundred and eight young. He also (Proc. Soc. Exptl. Biol. and Med., vol. xvi., p. 125) finds that the children and grandchildren of parents which had been treated with alcohol for two months before the birth of their young were less apt than the controls in learning to run a maze or to make a multiple choice.

The Leguminosæ are well known to have usually compound leaves, but several genera have unifoliolate varieties, or even species. Blakeslee (*Journal of Heredity*, April, 1919) describes such a form arising as a mutation in the Adzuki bean (*Phaseolus angularis*). His studies of Datura (Blakeslee and Avery, *Journal of Heredity*, March, 1919) have disclosed a number of new forms differing from the type in shape of capsule, foliage, and other characters. They transmit their characters as a complex, chiefly through the female, and in one instance a distinct new species seems to have arisen which breeds true, but appears to be sterile in crosses with the parent species.

R. R. G.

Increase of Population—a Warning.

PROF. E. M. EAST has much that is important in his address as retiring president of the American Society of Naturalists, meeting at Princeton (*Scientific Monthly*, vol. x., 1920, pp. 603–24). At present there are about 1700 million people, with an annual increase of between 14 and 16 millions. The white race is increasing much more rapidly than the yellow or the black. China's 300 million population is practically stationary. With the exception of France, few white peoples are increasing at a less rate than 10 per thousand. It is true that in most of the civilised countries of the world the birth-rate is slowly but steadily decreasing, but the result is not what many would have us believe. Where the birth-rate is low, the death-rate is low, except in France. Prof. East predicts that, owing to the steadily increasing development of preventive medicine, the decrease in the birth-rate will have no great effect on the natural increase in the world for many years to come. If the rate of increase actually existent during the nineteenth century in the United States should continue, within the span of life of the grandchildren of persons now living the States will contain more than a billion inhabitants. "Long before this eventuality the struggle for existence in those portions of the world at present more densely populated will be something beyond the imagination of those of us who have lived in a time of plenty." The law of diminishing returns is even now in operation in a comparatively new country like America, thought to be supplied with inexhaustible riches. Prof. East considers in detail what may be done by improved utilisation of energies, improved agriculture, improved breeding, and so on; but he is not sanguine. To the criticism that he has not allowed for the "immense possibilities in the way of utilising sea food," he responds with vigour. The cloud grows denser when it is noticed that the birth-rate of the foreign population of the United States, coming largely now from eastern and southern Europe, is so much greater than that of the Anglo-Saxon stock (to which, it is claimed, most of the superior types belong) that within a century the latter will be but a fraction of the whole. Prof. East looks forward to severe restriction of immigration; the spread of education; equitable readjustment in many economic customs; rational marriage selection which will tend to an increase of the birth-rate in families of high civic value; and among the rank and file a restriction of births commensurate with the family resources and the mother's strength.

Glass Technology.

WE have received from the Department of Glass Technology, University of Sheffield, a copy of vol. ii. of "Experimental Researches and Reports" published by that department. The papers included have already appeared in the Journal of the Society of Glass Technology. They range over a somewhat wide field of the glass industry, and include papers dealing with bottle-glass and glass-bottle manufacture, chemical glassware, glass for lamp-working purposes, besides accounts of such relevant investigations as the accurate calibration of burette tubes, a simple apparatus for the detection of strain in glass, and the annealing temperatures of lime-soda and magnesia-soda glasses. There are also a paper descriptive of the glass industry of North America and an account of the year's progress in glass research under the auspices of the Glass Research Delegacy. The condition of the glass industry in this country undoubtedly calls for sustained and systematic research, and this contribution of the Department of Glass Technology of the University of Sheffield must be of considerable assistance to what should be a great and national industry. The newly founded Glass Research Association has also an extensive programme of research in the field of what may be called industrial and laboratory glass, and the British Scientific Instrument Research Association is also more particularly concerned with investigations into optical glass. With such a measure of co-operation and co-ordination as the development of the researches shows to be necessary between these various bodies, there is hope that the users of all types of glass in this country may be able to find a home supply equal, if not superior, to the foreign sources to which, before the war, they perforce had to go for much of the glass they needed.

Rate of Evolution.

PROF. E. G. CONKLIN discusses (*Scientific Monthly*, 1920, vol. x., pp. 589–602) the difficult question of the rate of evolution, including under evolution (*a*) diversification of species, (*b*) more perfect adaptation to the conditions of life, and (*c*) increasing differentiation and integration, or, more briefly, progress. If the rate of diversification ("divergent evolution") depends upon the number of mutations that appear, Prof. Conklin argues that it should be proportional, other things being equal, to the rate of reproduction. But this does not seem to be the case. If the rate of improvement in adaptation ("adaptative evolution") depends upon the rate of mutation and the severity of elimination, it also should be proportional to the rate of reproduction; but the finely adapted birds and mammals have a relatively low rate of reproduction. If the rate of "progressive evolution" depends upon the rate of mutation and the severity of selection, it again should be proportional to the rate of reproduction; but the most complex and most highly differentiated of all animals have the lowest rate of reproduction. In face of the difficulty of accounting for the differences in the rate of evolution, Prof. Conklin doubts whether current theories as to the causes of evolution are wholly satisfactory. It may be doubted, however, whether we are able to state the problems of diversity of rate with sufficient precision to allow of their being used as tests of the validity of the ætiological formulæ in the field. It is likely enough that there are factors of organic evolution still to be discovered, but we do not think that Prof. Conklin exhausts the potency of those that are already known. Thus, after writing: "It seems highly probable that the rate of mutation is influenced by environmental conditions, as Plough has shown in the case of the pomace-fly, and it is probable that environment has played a large part in the rate of evolution," he adds: "On the other hand, the evidences against the inheritance of the effects of use and disuse are so strong that one hesitates to invoke their aid." We submit, however, that the *rôle* of a changeful environment in affording mutational stimulus has very little to do with its *rôle* in imprinting modifications. We agree, all the same, with Prof. Conklin that there is no reason for supposing that the formulation of the factors in evolution is approaching exhaustiveness. Ætiology is still a young science.

University and Educational Intelligence.

THE Air Ministry announces that Dr. O. S. Sinnatt, lecturer in mechanical engineering at King's College, University of London, has been appointed professor of aeronautical science at the R.A.F. Cadet College, Cranwell.

WE learn from *Science* for August 27 that the family of the late Sir John Darling, of Adelaide, South Australia, has contributed the sum of 15,000*l.* towards the cost of erecting a new building for the medical school of the University of Adelaide. This building will be designed to accommodate the departments of physiology, biochemistry, and histology, and the medical library. The building will be erected and equipped at a cost of 25,000*l.*

A FULL account of the courses of instruction in the various departments of Bradford Technical College will be found in the calendar which has just been issued. Full-time day courses in technical sciences are provided which extend over three or four years; they lead to the college diploma. Part-time courses, mainly evening work, are also given. The latter are intended to meet the needs of those who are engaged in industry during the greater part of their time. Special facilities are also given to students who may wish to undertake advanced study or research work. The college is well provided with laboratories, among which may be mentioned the engineering and testing shops, a complete plant for the production of textiles, and a power-house which has been arranged for demonstration purposes.

THE calendar of Birkbeck College has been issued, and contains useful information for students intending to take degrees at London University. The courses provided by the college are set out in detail; they consist of day and evening courses in the faculties of arts and science, and evening courses in the faculties of laws and economics. Facilities are also provided for post-graduate and research work. During the autumn and spring terms special courses of lectures on the history of London will be given, and there will also be four lectures, commencing October 11, on "The Thomson Effect" by Mr. H. R. Nettleton for the physics side. Particulars of university and other courses can be obtained from the office of the college or by letter to the secretary.

THE calendar of the London School of Economics and Political Science has been issued, and contains a detailed syllabus of all the courses available for students. Classes are open to those who intend to proceed to degrees in economics and commerce, and also to such as wish to pursue specialised or advanced study on topics on which they may be engaged. All the courses necessary for the degrees of B.Sc.(Econ.) and B.Com. are given at hours which make it possible for both day and evening students to take them. The school provides courses for a number of university diplomas and school certificates; among these are the university diploma for journalism, the academic diploma in sociology and social science and the certificate in social science, the academic diploma in geography, and the commercial and geography certificates granted by the School itself. Facilities are also provided for students desirous of proceeding to the degrees of Master and Doctor of Science, Philosophy, Laws, and Literature.

IN the calendar of the Merchant Venturers' Technical College, Bristol, attention may be directed to some novel features which are mentioned. The first is the Bristol "sandwich" scheme of training for engineers. This course takes five years to complete, about half of which are spent in a works and the other half in the university. A number of engineering firms co-operate with the college for this instruction, and others have expressed their willingness to accept students who have completed the course, in some cases at reduced premiums. Another feature of the college is a two years' course for apprentices. The curriculum extends over two years, and the classes take up one day each week. Students who pass the two examinations given will receive the Engineer Apprentice's Testamur. A series of popular lectures will also be given during the autumn and spring, two of which should be of scientific interest, namely, "Lightning and Thunder," by Prof. J. T. Macgregor-Morris, and "Devices which Won the War," by Mr. J. R. Raphael.

Societies and Academies.

PARIS.

Academy of Sciences, August 23.—M. Henri Deslandres in the chair.—A. **Lacroix**: The existence in Madagascar of a silicate of scandium and yttrium, thortveitite. This mineral, the richest known in scandium, was discovered in 1911 by J. Schetelig in Norway, and since that time has not been found in any other locality. Amongst specimens collected from the pegmatite of Befanamo, Madagascar, was one which agreed in its physical properties with the mineral described by Schetelig. The presence of scandium, ytterbium, and neoytterbium was confirmed by the spectrograph, and there were also indications of zirconium, aluminium, and titanium. In view of the importance of obtaining a sufficient supply of scandium for a more complete study of this element, other minerals from this region have been examined spectroscopically, and scandium has been detected in cymophane, a mineral not hitherto reported as containing this metal.—E. **Bourquelot**: Remarks on the biochemical method of examining hydrolysable glucosides by emulsin, with reference to the note by M. P. Delauney. Historical account of the results obtained since 1901 by the application of this method. Glucosides have been discovered and isolated in fifty-six species of plants.—E. **Cosserat**: Stars the annual proper motion of which exceeds 0·5″. An addition of two stars to the list published on September 1 in the *Comptes rendus*.—I. **Fredholm**: The reduction of a problem of rational mechanics to a linear integral equation.—P. **Humbert**: The function

$$W_{k, \mu_1, \mu_2 \ldots \mu_n}(x_1, x_2, x_3, \ldots x_n).$$

—W. **Swyngedauw**: The supertensions created by the three harmonics of saturation in triphase transformers.—P. **Bary**: Colloidal sulphur.—P. **Delauney**: The extraction of glucosides from two indigenous orchids: the identification of these glucosides with loroglossin. Details of the extraction of the glucosides from *Orchis simia* and *Ophrys aranifera* are given; the melting points, rotatory power, colour reaction with sulphuric acid, and products of hydrolysis proved the identity in each case with loroglossin.—A. **Krempf**: A new planariform Ctenophore, *Coeloplana gonoctena*.—J. **Feytaud**: The destruction of ants by chloropicrin. Chloropicrin has a destructive effect on the wood-mining ant, *Leucotermes lucifugus*, and particulars are given of the best method of applying this substance for the disinfection of houses.—A. **Paillot**: *Coccobacillus insectorum*. Remarks on a recent note on the same subject by MM. Hollande and Vernier.

SYDNEY.

Linnean Society of New South Wales, July 28.—Mr. J. J. Fletcher, president, in the chair.—A. A. **Hamilton**: Notes from the Botanic Gardens, Sydney. Species of Lepidosperma and Prostanthera and varieties of *Grevillea punicea, Hakea saligna,* and *Prostanthera saxicola* are described as new. New locality records are made for several other species.—J. **Mitchell** and W. S. **Dun**: The Atrypidæ of New South Wales, with references to those recorded from other States of Australia. In addition to the three species of Atrypa already known from New South Wales, three species are described as new. Specimens from Molong, Yass, and Bowning, which externally resemble Meristina, but the internal structure of which shows them to belong to the Atrypidæ, are referred to a proposed new genus. The records of Atrypa from Queensland, Victoria, and Western Australia are revised.—Marjorie I. **Collins**: Note on certain variations of the sporocyst in a species of Saprolegnia. In the species of Saprolegnia examined, Leptolegnia, Pythiopsis, and Achlya conditions of the sporocyst occurred rarely, while the Dictyuchus and Aplanes conditions were frequent; the variations occurred in both club-shaped and cylindrical sporocysts, but were not observed arising from resting sporocysts. Composite sporocysts were observed combining the features of Dictyuchus and Aplanes. Evidence is given in favour of the suggestion that the Aplanes condition has arisen from the Dictyuchus by failure of the protoplast to escape from the germ-tube during its early growth.—Prof. W. N. **Benson**, W. S. **Dun**, and W. R. **Browne**: The geology and petrology of the Great Serpentine Belt of New South Wales, part ix. The geology, palæontology, and petrography of the Currabubula district, with notes on adjacent regions. The relationship structurally and stratigraphically between this region and that formerly described by the writer in the Burindi and Horton River districts is indicated. In the Currabubula district the oldest formation is the Burindi mudstone with tuffs, followed by the Middle Carboniferous Kuttung series, largely composed of keratophyre-tuff and conglomerates, but containing two or three horizons of contorted, seasonally banded "varve-rock" of fluvioglacial origin, accompanied by tillite containing striated, and occasionally faceted, erratics. This series is 9500 ft. in thickness, and contains Rhacopteris and other fossil plants. It is followed by the Werrie series of basalt-flows, which are invaded by a very varied series of sills and dykes radiating from Warragundi Mountain, related to which is an extensive series of keratophyric, andesitic, doleritic, and basaltic sills and dykes which invade the Burindi, and especially the Kuttung rocks.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings, vol. vi., No. 2, February).—Messrs. **Harkins** and **Ewing**: An apparent high pressure due to adsorption, the heat of adsorption, and the density of gas-mask charcoals. In addition to the volume of the pores and density of the active charcoal, the effect of the compressibility, viscosity, and surface tension of the liquid are discussed.—H. J. **Spinden**: Central American calendars and the Gregorian day. Rules are set up for turning Mayan and Mexican dates into the Gregorian calendar so that American history is made more exact than that of Egypt, Greece, or Rome.—C. **Barus**: The torsional magnetic energy absorption of an iron conductor.—Y. **Henderson**: The adjustment to the barometer of the hæmatorespiratory functions in man. It appears that the blood-alkali is controlled by the dissolved CO_2, the amount of CO_2 by preliminary ventilation, and the ventilation by the oxygen partial pressure of the air.—A. S. **King**: A study of absorption spectra with the electric furnace. The tube-resistance furnace hitherto used for the study of emission spectra offers interesting possibilities also in the field of absorption spectra.—A. S. **King**: A study of the effect of a magnetic field on electric-furnace spectra. Lines common to furnace and to spark spectra show no difference in number of components nor in separation; the furnace may thus be used to supplement the spark.—D. F. **Jones**: Selective fertilisation in pollen mixtures. Experiments on maize show that there is a definite receptiveness of the plant to its own kind of pollen, and that in proportion as the cross-fertilisation benefits the progeny the less effective are the germ-cells in accomplishing fertilisation. The writer believes that the assumption that heterogeneity in protoplasmic structure is favourable to developmental efficiency is founded on fallacious reasoning and not supported by the facts.—G. A. **Miller**: Groups generated by two operators, S_1, S_2, which satisfy the conditions $S_1^m = S_2^n$, $(S_1S_2)^k = 1$, and $S_1S_2 = S_2S_1$. Results useful in the study of the generalised groups of the regular polyhedra.—W. E. **Castle**: Model of the linkage system of eleven second-chromosome genes of Drosophila. Continuation of the discussion of the spatial *versus* linear arrangement of the genes with the conclusion that in this case the arrangement appears linear.—G. A. **Baitsell**: The development of connective tissue in the amphibian embryo. The origin of connective tissue lies in an intercellular secretion of the embryonic cells which constitutes the ground substance of the connective secretions from the cells. Under various chemical and mechanical factors this substance forms connective tissue-fibres by consolidation of its minute elements.—F. P. **Underhill**, J. A. **Honeij**, and L. J. **Bogert**: Calcium and magnesium metabolism in certain diseases. Clinically, in leprosy there is loss of bone-salts;

experimentally, the leprous organism tends to retain bone-salts, especially calcium. Clinically, in multiple exostosis bone-salts are inferred to be added to the body; experimentally, the organism tries to rid itself of bone-salts, particularly calcium, and in the stabilised stage throws out excessive quantities of magnesium.—C. G. **Abbot**: The larger opportunities for research on the relations of solar and terrestrial radiation. A general research survey communicated by the National Research Council.—S. R. **Detwiler**: The hyperplasia of nerve-centres resulting from excessive peripheral loading. The experiments proving these results consisted in transplanting the right anterior limb rudiment of *Amblystoma punctatum* a given number of body segments posterior to the normal position.

Books Received.

Department of Scientific and Industrial Research. Fuel Research Board. Special Report No. 3: The Coal Fire. By Dr. M. W. Fishenden. Pp. viii+112. (London: H.M. Stationery Office.) 4*s.* net.

Religion and Science. From Galileo to Bergson. By J. C. Hardwick. Pp. ix+148. (London: S.P.C.K.; New York: The Macmillan Co.) 8*s.* net.

Directions for a Practical Course in Chemical Physiology. By Dr. W. Cramer. Fourth edition. Pp. viii+137. (London: Longmans, Green, and Co.) 4*s.* 6*d.* net.

Organic Chemistry for Medical, Intermediate Science, and Pharmaceutical Students. By Dr. A. K. Macbeth. Pp. xi+235. (London: Longmans, Green, and Co.) 6*s.* 6*d.* net.

The Fireman's Handbook and Guide to Fuel Economy. By C. F. Wade. Pp. viii+84. (London: Longmans, Green, and Co.) 2*s.* 6*d.* net.

From Newton to Einstein. Changing Conceptions of the Universe. By Dr. B. Harrow. Pp. 95. (London: Constable and Co., Ltd.) 2*s.* 6*d.*

The Chemical Analysis of Steel-Works' Materials. By F. Ibbotson. Pp. viii+296. (London: Longmans, Green, and Co.) 21*s.* net.

A Second Course in Mathematics for Technical Students. By P. J. Haler and A. H. Stuart. Pp. viii+363. (London: W. B. Clive.) 6*s.*

Privy Council. Medical Research Council. The Science of Ventilation and Open Air Treatment. Part ii. (Special Report Series, No. 52.) Pp. 295. (London: H.M. Stationery Office.) 6*s.* net.

Induction Coil Design. By M. A. Codd. Pp. vi+239+iv plates. (London: E. and F. N. Spon, Ltd.) 21*s.* net.

The Year-Book of the Universities of the Empire, 1918–1920. Edited by W. H. Dawson. Pp. xiv+503. (London: G. Bell and Sons, Ltd.) 15*s.* net.

Icones Plantarum Formosanarum nec non et Contributiones ad Floram Formosanam. By B. Hayata. Vol. ix. Pp. vii+155+vii plates. (Taihoku: Bureau of Forestry.)

Air Ministry. Meteorological Office. British Meteorological and Magnetic Year Book, 1910. Part v., Réseau Mondial, 1910. Monthly and Annual Summaries of Pressure, Temperature, and Precipitation at Land Stations. Pp. xxiv+112. (London: Meteorological Office, Air Ministry.) 15*s.* net.

The Diary of Opal Whiteley. Pp. xxii+311. (London: G. P. Putnam's Sons.) 7*s.* 6*d.* net.

Ludwig Boltzmanns Vorlesungen über die Prinzipe der Mechanik. Dritter Teil. Elastizitätstheorie und Hydromechanik. Edited by Prof. H. Buchholz. Pp. xiii+608–820. (Leipzig: J. A. Barth.) 21.60 marks.

The Diary of a Sportsman Naturalist in India. By E. P. Stebbing. Pp. xvi+298. (London: John Lane.) 21*s.* net.

The Mining Laws of the British Empire and of Foreign Countries. Vol. i., Nigeria. By G. Stone. Pp. xxiii+254. (London: H.M. Stationery Office.) 15*s.* net.

Ordnance Survey Maps: Their Meaning and Use. By Dr. M. I. Newbigin. Second edition. Pp. 128. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 2*s.* net.

The Laws of Mechanics. By S. H. Stelfox. Pp. xi+201. (London: Methuen and Co., Ltd.) 6*s.*

William Sutherland: A Biography. By W. A. Osborne. Pp. 102. (Melbourne: Lothian Book Pub. Co. Pty., Ltd.; London: *British Australasian.*) 7*s.* 6*d.*

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. xvi., Refractory Materials: Ganister and Silica—Rock-Sand for Open-hearth Steel Furnaces—Dolomite. Petrography and Chemistry. By Dr. W. H. Thomas, A. F. Hallimond, and E. G. Radley. Pp. iv+115+vii plates. (Southampton: Ordnance Survey Office; London: H.M. Stationery Office.) 5*s.* net.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. v., part 1. (Sydney: Botanic Gardens.) 2*s.* 6*d.*

Solubilities of Inorganic and Organic Substances. By Dr. A. Seidell. Second edition. Pp. xxii+845. (London: C. Lockwood and Son; New York: D. van Nostrand Co.) 45*s.* net.

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