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The Tuberculosis Problem.

THE forthcoming international conference on tuberculosis, which is to be held in London on July 26–28, is likely to provide some considerable additions to our knowledge of this chief of diseases, and may, it is hoped, serve also to give heart to those engaged in the preventive and curative work which has stood the test of trial. The president of the International Union against Tuberculosis is the eminent French jurist and statesman, M. Léon Bourgeois, and it is significant of the double *rôle* of the conference that Prof. A. Calmette, of Lille, will open a discussion on the modes of diffusion of tuberculosis throughout the races of the world, while an English physician, Sir H. Rolleston, will open another discussion on the duty—too much neglected—of the medical profession in the prevention of tuberculosis.

On the first subject much additional light has been thrown by the investigations of Metchnikoff and of Prof. Calmette himself, and by the further evidence marshalled, a few months ago, in an interesting contribution by Prof. Cumming, of the University of Wales, to the *International Journal of Hygiene*. In a recent volume on "The Epidemiology of Pulmonary Tuberculosis," Col. Bushnell, of the U.S. Army Medical Service, who will take part in the London conference, has collected a mass of evidence on the racial incidence of tuberculosis, which enables us to approach to a definite understanding of the remarkable differences in the death-rate from tuberculosis in different races. Briefly and, therefore, imperfectly summarised, the general trend of facts indicates that the differences displayed between different races are largely, if not entirely, explicable by consideration of the age at which exposure to infection by tubercle bacilli first occurs, by the dosage of infection which is received, and by the social and sanitary circumstances in which populations are infected. There may be—and it is not improbable that there are—true racial differences in susceptibility to infection, due to the fact that certain races have not experienced the selective effect of exposure during many generations to infection. Nevertheless, although this factor cannot be excluded by any directly available evidence, it is scarcely consistent with its operation on a large scale that there exist remarkable differences in respect of mortality from tuberculosis between persons in various social strata and industrial occupations and between communities the members of which have all been exposed for many generations to the ravages of this disease.

Whatever view is taken of the selective influence of exposure to tuberculosis in successive generations, epidemiological facts show clearly that the amount of tuberculosis in adult negroes, for instance, is determined in large measure by their past individual experience in respect of exposure to the infection of this disease. In Army experience, negroes who have previously lived under urban conditions have had little more tuberculosis than white men under similar conditions. In the past much error has arisen from not comparing white and coloured populations of corresponding social status. Negroes commonly live in overcrowded houses, are badly fed, and are extremely dirty in their habits; comparison should therefore be between them and the occupants of common lodging-houses, rather than between them and the average white population.

When, however, negroes who have previously lived in remote parts where tuberculosis is not prevalent are exposed to infection, they suffer to an extraordinary extent. The same remarks apply to Red Indians and other races having a similar antecedent experience. This difference between persons not exposed in early life to infection and others who have been so exposed holds good, as is well known in Army experience, for measles. Adults, whether coloured or white, who have not previously been exposed to measles suffer much more severely from this disease than the average adult. In this instance, also, the operation of natural selection is conceivable, but it may be that the *differentia* between the two classes lies in the acquired immunity due to attacks in early life, or to the vaccinal influence of small repeated doses of the specific contagium. There is little doubt, however, that at the forthcoming conference Prof. Calmette and others will marshal the evidence bearing on this and allied disputed points.

It is too little known that, even in a country like England, in which tuberculosis has long been endemic, the highest death-rate from this disease occurs during the first five years of life. In the first year after birth one death out of every twenty-six from all causes is certified to be due to tuberculosis; the real proportion is much higher, many deaths returned as due to pneumonia or bronchitis being cases of acute tuberculosis. Landouzy has stated that 27 per cent. of the deaths in the first two years of life are caused by tuberculosis. The practical lesson from these facts is that in childhood in every race there is but little resistance to the infection of this disease. If, therefore, the total human death-roll at all ages from tuberculosis is to be lowered, it is of supreme importance to prevent children from being exposed to infection during the first five years, and especially during the first two of these years.

The heavy child mortality from tuberculosis is followed by a lull in the incidence of the disease. Then there occurs a second peak of heavy mortality from tuberculosis in its pulmonary form, which in some communities is as high as, or even higher than, that in childhood. Dr. Brownlee has made some ingenious suggestions as to the reasons for the different ages at which this second peak reaches its maximum in various sections of the country, and it is to be hoped that this subject will receive adequate discussion at the forthcoming conference. Dr. Brownlee's suggestion that male adult tuberculosis has a different origin, according to the shape of the curve, must be tested by the construction of similar curves of female mortality. Moreover, it remains to be shown that the varying age-incidence of maximum mortality from tuberculosis in different areas is not the result of varying exposure to infection and to circumstances calling latent tuberculosis into activity, rather than of a different etiology.

The double age curve of tuberculosis mortality in civilised urban communities throws light on the excessive mortality from tuberculosis among native races. In this country children who have received (and possibly continue to receive) small doses of infection not competent to produce active disease acquire a relative immunity, which is overcome only when irritating dust, excessive fatigue, alcoholism, or an acute illness lowers personal resistance to a dangerous point. There was ample experience of these causes of excessive tuberculosis during the Great War. If native races are not thus "salted" in early life, they suffer excessively when exposed to tuberculosis in later life. Hence, as already indicated, the importance of safeguarding young children against protracted exposure to infection, and in later life of the segregation of bedridden cases of tuberculosis and of other patients living in unhygienic circumstances. In addition there are general measures of hygiene and improved nutrition the value of which in reducing tuberculosis is beyond question.

The practical aspect of special tuberculosis work will doubtless be discussed from many points of view at the London conference. It is common ground that the notification of tuberculosis to the Medical Officer of Health is an indispensable link in the chain of preventive measures. Unfortunately, it is well known that notification is imperfectly carried out by a large proportion of medical practitioners, who often do not notify cases for several months after they have come under their care. Thus the possibility of the more active preventive measures necessary is delayed.

The general relationship of the private practitioner to the prevention of disease is of fundamental importance if rapid progress is to be made. How to harness him to public health work is perhaps the most difficult, as well as the most important, problem of State medicine. At present he is often a hinderer of progress, though in other instances he is the most valuable of State servants. This subject also will doubtless be discussed at the forthcoming conference.

It cannot be said that the medical machinery of the National Health Insurance Act has helped. When we recall the fact that, even in present circumstances, a panel doctor may sometimes have as many as 3000 insured persons on his list, for whom he receives the annual payment of 1650*l.*, while he is also allowed to take other private patients, it cannot be expected that the adequate examination of all suspected cases of tuberculosis and their early treatment can be satisfactorily undertaken.

The essential point to be realised in practice—

and we are far from this at present—is that we cannot expect complete success in anti-tuberculosis work until we are in a position to say that "we are exercising complete supervision over, and making provision for, the whole of the sick life of the consumptive, whether he is trending towards complete recovery or towards death." There is not a single community in Great Britain concerning which that statement can be affirmed. The nearest approach to it is what is known as the Framingham experiment, which has been going on for four or five years in a small town in Massachusetts, and of which a valuable account has been published by the American Tuberculosis Association. It is to be hoped that a full account of this experiment, and the results which have been obtained, will form part of the proceedings of the forthcoming conference in London.

The Foundations of Physics.

Physics: The Elements. By Dr. Norman R. Campbell. Pp. ix+565. (Cambridge: At the University Press, 1920.) 40*s*. net.

DR. CAMPBELL has attempted with great courage a very ambitious task—that of discussing critically the fundamental conceptions, propositions, and methods of the science of physics. A rough idea of the nature of his work may be given by saying that he attempts to do for the foundations of physics what Peano, Whitehead, Russell, and others of the modern critical school have done for the central principles of mathematics. The spirit, however, rather than the exact method of these mathematical philosophers is what he emulates, for, apparently, one of the factors which determined him to write this book was a lively dissatisfaction caused by the fact that hitherto all inquiry of this nature in physics has been carried out by mathematicians rather than by experimenters. Mach, of course, in spite of Dr. Campbell's implication, was an experimenter of note, as well as a mathematician and philosopher, but our author aspires to a somewhat more complete and general discussion than that carried out by Mach for certain branches of physics, and wishes to include recent developments. Again, he is more anxious to win the confidence of the man in the laboratory (who, as he says, is often "not merely uninterested in fundamental criticism, but positively hostile to it"), while at the same time desiring to meet the logicians on their own ground, if not with their own weapons. From a window in his study he looks down with sympathy upon the laboratory, and writes with one eye on the bust of Mr. Bertrand Russell, serene above the conflict, and with the other on the working physicist, who is cursing alternately his electrometer and the theory of errors.

Dr. Campbell realises clearly that the physicist is not necessarily either logical or consistent when he is most efficient. This realisation is an important feature of the book, and distinguishes the author from his predecessors. "It is undoubted," he says, "that we can study science with perfect satisfaction to ourselves . . . although we commit the heinous offence of using ambiguous terms. And this fact is simply an indication that we do not use in the course of our study any processes which require words to be unambiguous." "Illogical is not synonymous with erroneous." Again, he insists more strongly upon the fundamental importance of analogy than do most writers on the principles of science, contending that analogies are not so much aids to the establishment of theories—the usual view—as essential parts of the theories. The theories are systematic expressions of analogies. Here, we think, he will not only interest all physicists, but also carry them with him. On the other hand, his discussion of such points as how we can define, say, silver, and his conclusion that all logical difficulties can be avoided by stating "silver exists," will not, possibly, appeal to the experimenter. The experimenter has never felt the need of a formal definition of his materials; Dr. Campbell agrees, but labours the point at considerable length, whereas the question of modern conceptions of isomers and isotopes, which will bear much discussion, receives little attention.

The book before us (the preface informs us that further volumes have been contemplated) is divided into two parts, one dealing with the propositions of science, and the other with measurement. The first consists in the main of a discussion of the nature of laws, hypotheses, and theories, of what is meant in physics by these terms, and of the possibility of obtaining more or less formal definitions of them. Dr. Campbell's debating often tends to show the difficulty of arriving at conclusions rather than to lead us to convincing conclusions—a fact attributable to the difficulty of the subject. For instance, he suggests that the decision as to whether a given proposition is or is not a law has to be left to the judgment of serious students of science—which is sound, but not sensational. Throughout the book the word "important" plays a large part, and obviously to reduce a question to terms of relative importance is to raise fresh points. The discussion of theories, comparing as it does, in particular, the services of mechanical and mathematical theories, is of great interest. The aspect of a theory brought out so strongly by Mendeléeff's words, "By a theory I mean a conclusion drawn from the accumulated facts we now possess which enables us to foresee new facts which we do not yet know," might, perhaps, have been more emphasised.

Of Mill's canons of induction our author disposes in a very workmanlike manner. The chapter on chance and probability seems to us to contain some very sound and valuable remarks on the fundamental assumptions of this difficult study. An example in this chapter has already drawn down the wrath of an eminent mathematician; this example, which deals with the drawing of a given ace from a piquet and a whist pack side by side, at first sight appears to be made the ground of a somewhat perverse comment on ordinary reasoning, since it is admitted that the ordinary estimate of the probability is "right"; but actually it leads up to a point of some importance. The usual assumption is that the choice of either pack in the first instance is equally probable; but this does not follow from first principles unless further conditions as to blindfolding, and so on, are introduced. Actually, the chooser might well be considerably influenced in his choice by the relative size of the packs; and what is really the probability of drawing a given ace is a matter for experiment under conditions rigorously specified. The point brought out, though perhaps not that on which most stress is laid, is that the given conditions are often not stated precisely enough in problems of this nature.

The discussion on probability is continued in the second part, where the subject of errors of measurement is investigated. The criticism here is searching, but is not likely to be accepted in its entirety without debate: the suggestion that the physicist will more frequently find distributions in his notebooks which give a curve like the letter "A" with its top removed than a Gaussian curve will scarcely be accepted. No doubt his arguments will receive more detailed consideration from the experts than is possible here.

The chapter on units and dimensions deserves particular attention. It contains valuable observations on no-dimensional magnitudes and formal constants, as well as some startling suggestions, including what seems to be an implication that the arrangement of the terms in a dimensional equation is of importance.

Dr. Campbell writes with enthusiasm and seeks the combat where it is thickest. The chief fault of his style arises from a desire to deal with every possible comment that might be raised and hence to labour points which are sufficiently obvious. There is a certain lack of co-ordination, which he acknowledges; in fact, one of the things which render it an ungracious task to criticise is that the author is keenly alive to deficiencies in the book, and is always anxious to point them out himself. The work gives the impression of brilliant and informed table-talk on the basis of physics carried on evening after evening, the amount of thought devoted to any particular point depending largely on the mood of the moment. There is little doubt that most readers will find Dr. Campbell provocative in parts, but, whatever else he may provoke, he provokes thought. Finally, it is a great feat to have assembled so much interesting matter, and to have put together a book containing so much fresh thought on a subject of fundamental interest. It is to be hoped that the interest taken in this book will prove amply sufficient to encourage the author to bring out the contemplated remainder of the treatise.

E. N. DA C. ANDRADE.

Mind and Brain.

In Search of the Soul and the Mechanism of Thought, Emotion, and Conduct. By Dr. B. Hollander. Vol. i.: *The History of Philosophy and Science from Ancient Times to the Present Day.* Pp. x+516. Vol. ii.: *The Origin of the Mental Capacities and Dispositions of Man and their Normal, Abnormal, and Supernormal Manifestations.* Pp. vii+361. (London: Kegan Paul, Trench, Trubner, and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) *2l. 2s.* net two vols.

THAT the psychological phenomena loosely grouped together under the term "mind" are in some way correlated with the physiological activities of the brain is a proposition which may be regarded as having been generally accepted for more than a century past; the question, however, as to what is the nature of that correlation still remains unsolved. The fact that this particular question must be allowed to lie in abeyance does not militate against the very legitimate attempt to locate differentiated mental functions in relation to the various structural parts of the brain, and as a matter of course many observers have sought to produce a psycho-physiology of the brain.

The human brain is chiefly remarkable, from the point of view of comparative anatomy, for the extraordinary development of the cerebral hemispheres, which conceal practically all the other portions of the brain. They constitute virtually a great pall consisting of a grey surface or cortex, composed of many layers of innumerable nervecells, and a white medulla or stalk, composed of millions of nerve-fibres which connect the cortical cells with one another, with other structures in the brain, and with the body tissues generally. Conceive this mantle with a surface divided up by a very constant pattern of grooves and elevations the marvellously complex and unique structure of which had just come to light; then, bearing in mind the "faculty" psychology which was generally held a century ago, it is easy to comprehend the high hopes entertained and the attempts that were made to parcel out the faculties on to the surface so naturally prepared. From these attempts to localise the higher mental functions before the nature of cerebral physiology was at all understood arose the cult of phrenology and all the charlatanism to which it gave rise.

To the serious student, phrenology, the lore of telling the character from the prominences of the skull, became quickly discredited because it was obvious that, as the thickness of the skull bones varied irregularly, the external configuration of the skull bore no definite relation to the surface of the brain underneath. This circumstance did not interfere with the followers of the mental localisation theory, but they themselves soon began to experience difficulties of their own. To obtain any agreement on the matter of localisation, it was first of all necessary that each observer should hold precisely the same views as to the division of the mind into faculties, and this essential preliminary gave rise to much difficulty, because very few persons were agreed on the subject. Many schemes were propounded and much argument took place until it was seen that, from the purely psychological point of view, the "faculty" conception of psychology was untenable. From regarding, for instance, the quality of aggressiveness as a separate entity, the opinion was formed that it was a trend of the personality as a whole. Moreover, the independent experiments of the physiologists and the observations of the neurologists began to take definite shape, quite apart from the speculations of the philosophical psychologists.

A great deal of knowledge has now accumulated, and modern opinion, which is supported by the vast amount of detail derived from the many cases of head injury in the war, is very definitely against any possible cortical localisation of separate mental faculties. The modern theory is embraced by the broad statement that the cortex is to be considered as a vast associational mechanism functioning as a whole, the chief purpose of which is one of inhibition of the lower activities of the nervous system; in other words, it is the mechanism whereby a considered intellectual activity is substituted for an emotional reflexive type of reaction to environment. The cortex contains the termini of the various sensory streams of nerve-fibres arising in all parts of the body, and also the origin of the motor nerve-fibres going out to the muscles of the body. Apart from these connections, which have now been mapped with fair accuracy and are termed the sensory and motor areas respectively, there is no question of there being any real mental localisation. If the cortex be injured outside one of these areas, the individual becomes generally irritable or lacks control, and at the same time loses to a certain extent the capacity for intellectual thought.

Dr. Hollander, so one gathers from his book, does not agree with modern opinions. He prefers to stand by the old "faculty" psychology and the corresponding physiological ideas, and he has produced a monumental work in support of his views. In the very interesting first volume of his book he takes the reader right from the beginning of recorded philosophical speculation up to present-day knowledge of the mind and brain, extracts being given from and personal references made to practically every writer on the subjects under discussion. This mass of information, collated with a care that the reader will appreciate, must have involved a tremendous literary research and labour. It is only marred by the fact that the author stresses or belittles the facts to so great an extent in the effort to establish his point. His defence of the physiologist Gall, who was one of the first to take up the matter of cerebral localisation, is masterly; so much so that one sighs that such energy, ingenuity, and thought should have been expended in the resuscitation of a bygone stage of knowledge when there is so much new ground to be explored.

The second volume is disappointing. Here we have Dr. Hollander's views on many things; too many things really to be included within the same cover. A considerable portion of this volume is devoted to the development of his argument on behalf of the cerebral localisation of mental function, and to this end he lays down his psychology, which is of the faculty type and singularly lacking in reference to the most recent developments; *e.g.* there is no mention of such illuminating conceptions as that of the defence mechanisms or of the influence of the sympathetic and endocrine systems upon the mind. His treatment of the question of insanity is in the style of a very commonplace abridged text-book, not at all what one would have expected in a book of this kind; while some of his statements, though they may safely be left to the judgment of the professional reader, require a little criticism for the benefit of the layman in these matters.

Dr. Hollander, like all enthusiasts, is inclined to lay the onus of failure of vision on those who do not agree with him. He disposes of his opponents on the ground that they do not follow out his system; but he must realise that some of the greatest intellects in science have been busy on these problems, and that they cannot all be wrong and only he be right. He must give a little credit to the labours of such men as Sir Frederick Mott, Sir Victor Horsley, and many others one might mention. Again, the difficulty the physicians of our mental hospitals have to face is not the fact that they are not allowed to fulfil their duty—they have every opportunity to do that in the very efficient and well-equipped modern mental hospital—but the attitude of the friends and relatives of the mental patient who, for sentimental reasons, oppose any effort to place the patient under proper care in the early stages of the disorder. As regards the question of treatment, of course everyone is entitled to whatever opinion he chooses, but it may be as well to point out that the consensus of modern opinion is that the day has not yet dawned when mental disorder can be treated by the surgeon. In a few cases of very definite brain injury an operation might be considered, but, even so, it is often found that the patient's last state is no better than the first.

Space does not permit of any detailed criticism of the remaining chapters of the book; it must suffice to say that the author passes on from criminology to thought reading and allied subjects, and ends upon a metaphysical note. The book is well written and well arranged; every credit must be given for the truly immense labour involved in its compilation; but it is to be feared that it is too much out of joint with the times to exercise much effect on the opinion of the day on these matters.

Mineralogy for Students.

(1) *Economic Mineralogy: A Practical Guide to the Study of Useful Minerals.* By T. Crook. Pp. xi+492. (London: Longmans, Green, and Co., 1921.) 25*s.* net.

(2) *Mineralogy: An Introduction to the Study of Minerals and Crystals.* By Prof. E. H. Kraus and Dr. W. F. Hunt. Pp. xiv+561. (New York and London: McGraw-Hill Book Co., Inc., 1920.) 27*s.*

EACH of these books is intended both as a text-book for students and as a work of reference for practical men.

(1) In Mr. Crook's case the reader has the advantage of his life-long employment on the economic investigation of minerals, while his experience as a lecturer enables him to appreciate the difficulties of the beginner. He carefully avoids unnecessary excursions into theoretical considerations, but his explanations, so far as they extend, are exceptionally clear and simple. He gives considerable attention to the optical examination of crystals, on account of its value in recognising minerals; and there is a helpful chapter on the use of the blowpipe and chemical methods generally. Another chapter is concerned with the physical analysis of crushed rocks and loose detrital sediments, a subject that the author has made peculiarly his own; and the short account of the geology of mineral deposits should be of use to the prospector.

The greater portion of the book is, however, devoted to a detailed description of the minerals of practical importance. The arrangement and treatment are frankly based on economic considerations, which should be a recommendation to all who are engaged in the commercial development of mineral resources. Moreover, Mr. Crook does not confine his attention to minerals in the strictly scientific meaning of the word, but includes all that is covered by the legal and technical definition of the term—everything which is mined for its economic value—so that coal, asphalt, and petroleum find their place in his survey. He also deals briefly with building materials and road metal. The volume concludes with some useful determinative tables, which are set out in such a manner that it is possible to glance rapidly through them in search of the information required. The text is illustrated by clear diagrams, and by excellent photographs of minerals taken by the author himself.

(2) Prof. Kraus and Dr. Hunt present us with a treatise of a somewhat more elaborate character, largely compiled from previous publications of one or both of the authors. Considerable attention is devoted to crystallography, and there are detailed tables for determining minerals. In the general description of the commoner minerals they are arranged according to the usual chemical classification, but there is a separate chapter on gem-stones, and another in which the minerals are classified according to the elements to which they owe their economic value. Monazite, however, appears in this section under cerium, which, although present in considerable amount, is of little commercial importance, instead of under thorium, for which it is almost exclusively worked. The use of tetra- (instead of tetarto-) in referring to a quarter-pyramid in the triclinic

system should be corrected in another edition, as should also a few misprints (especially on p. 319). These are, however, matters of minor importance.

Taken as a whole, the book appears to be carefully and attractively written, and is illustrated by photographs of both minerals and crystal models, though it is doubtful whether the latter are really more effective than the line drawings that accompany them. There are also photographs of distinguished mineralogists, past and present, but a *caveat* must be entered to the claim that Werner was the first to place mineralogy on a scientific basis. The credit of the foundation of the science must be shared by some of his predecessors, such as Cronstedt, as well as by contemporaries like Kirwan.

JOHN W. EVANS.

Our Bookshelf.

Elements of the Mathematical Theory of Electricity and Magnetism. By Sir J. J. Thomson. Fifth edition. Pp. viii+410. (Cambridge: At the University Press, 1921.) 30*s*. net.

EARLIER editions of this book were fully reviewed in NATURE, but the alterations and improvements in the present edition deserve special notice. One change—that in the treatment of hysteresis—makes the subject of energy dissipated in the magnetic field much clearer to the student. A piece of iron is put through a magnetic cycle and it is imagined as being displaced from one position in the field to another. The thing emphasised is the work done in effecting a displacement of a magnetic element in the field, which is $la\text{I}\delta\text{H}$, where H is the field intensity, I the intensity of magnetisation, and la the volume of the element. The former way of putting the matter puzzled the thoughtful student, while the thoughtless person accepted it without analysis of its meaning. It was said that "the diminution in the potential energy when the magnet moves into the stronger field is $\text{I}al\delta\text{H}$." The change in potential energy was not this, but $la(\text{I}\delta\text{H}+\text{H}\delta\text{I})$, and the thinker naturally wondered what had become of the term $la\text{H}\delta\text{I}$.

The most natural and convincing method of considering this matter is that due to the late Dr. John Hopkinson, and given when an attempt was made (not in this book) to demonstrate the hysteresis formula by juggling with the terms of the variation of a perfect differential. This method of Hopkinson's is to be found on p. 339. It considers the work thrown into the field from the battery when the magnetisation is changed by a magnetising current.

An interesting discussion of a gas the molecules of which are small magnets has also been added.

On the whole this edition of a sound and popular book is brought well up to date. All the alterations will be thoroughly appreciated by the student except that in the price, which has made a prodigious leap. It is a difficult time, as everyone knows, but many a student who would have willingly added this book to his own little stock of standard works will have to content himself with borrowing it.

A. GRAY.

Metabolism and Growth from Birth to Puberty. By F. G. Benedict and F. B. Talbot. (Publication No. 302.) Pp. vi+213. (Washington: The Carnegie Institution of Washington, 1921.)

BENEDICT and Talbot's work on the "Metabolism and Growth from Birth to Puberty" of children of both sexes aged from one week up to fifteen years is a continuation of that on new-born infants published six years ago. The children were all physiologically normal, and some of the data are from the same children at different ages. Measurements of the weight, height, pulse-rate, and body-temperature are recorded, as well as the basal metabolism figures—*i.e.* the heat evolved in twenty-four hours in the subject at quiet repose and in the post-absorptive condition. These conditions were not easy to attain in the case of infants; there was not usually quiet repose unless some food was in the alimentary tract, but occasionally measurements were made as long as nine hours after a meal. The data are thus rather above the real basal figures than below. The basal metabolism is referred to age, weight, height, and body surface in a series of curves. The body surface was calculated by the Du Bois formula from actual measurements. Weight and height run parallel with age, and the basal metabolism increased from approximately 150 to 1100 Calories. In comparison with body surface the basal metabolism rose rapidly during the first year; after this age there was a continual decrease. There was no marked difference between the sexes, but after reaching the weight of 11 kilograms boys had a slightly higher metabolism than girls. All the data for basal metabolism are lower than those recorded by previous investigators. The publication is a valuable contribution to physiological literature.

Chemistry. By G. H. J. Adlam. ("Science for All" Series.) Pp. x+238. (London: John Murray, 1921.) 3*s*. 6*d*. net.

THE book under notice is intended for a beginner who is "guided and inspired by a competent teacher." Many recent discoveries are included and the material is, on the whole, presented in an accurate and readable form. Several minor errors are, however, noticeable. Glaziers' "diamonds" are not "splinters" (p. 110); oxygen is not used in determining the flash-point of an oil (p. 119); the experiment described on p. 157 seems unlikely to succeed; the recovery of sulphur from alkali-waste is not without value (p. 170); and the carbon arc is not used in the fixation of nitrogen (p. 184). The atomic theory is explained only at the end of the book, although the method of counting the α-particles expelled from radium is referred to on p. 10.

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.*]

Radiation from the Carbon Arc.

AN application of Merton and Nicholson's form of the wedge method has been made to the study of the intensity distribution in typical stellar spectra. In the late type spectra (including the sun), which are sufficiently bright at the red end, the energy curves give a marked depression from 0·50–0·67μ—a result not obtained by other observers. As the spectrum of the carbon arc, assumed to radiate as a black body at a temperature of 3750° Abs., is used to remove the colour curve of the plate, a possible cause of this depression, which is common to all stellar spectra that have been observed in the red, would lie in an intensity distribution in the carbon arc differing from that assumed.

In order to determine the intensity distribution in the spectrum of the positive crater of the carbon arc, the acetylene flame was used as a standard. The intensity distribution in a cylindrical flame of specified dimensions burning acetylene generated from commercial calcium carbide has been carefully determined by Coblentz with the bolometer (Bureau of Standards, Scientific Papers No. 279, 1916, and No. 362, 1920). To reproduce as closely as possible the conditions employed by Coblentz, a burner was used giving a cylindrical flame of the specified dimensions, and the acetylene used was obtained from three different sources: two cylinders containing acetylene compressed in acetone and a simple gasometer which generated gas from commercial calcium carbide. From 0·40–0·60μ the intensity distributions in the flames from these three sources were in good agreement. From 0·60–0·675μ there were systematic differences with a range of 8 per cent., due probably to the varying quality of the acetylene. In this part of the spectrum mean intensities were used as giving the closest approximation to Coblentz's conditions. Some initial experimental difficulties were encountered owing to non-uniform illumination of the wedge by the flame which could not be detected by the usual methods. It was found that reversal of the wedge on the slit furnished a very sensitive test of uniformity, and by the use of this method an arrangement of apparatus was secured which gave uniformity of illumination within the limits of the accidental errors of the wedge method.

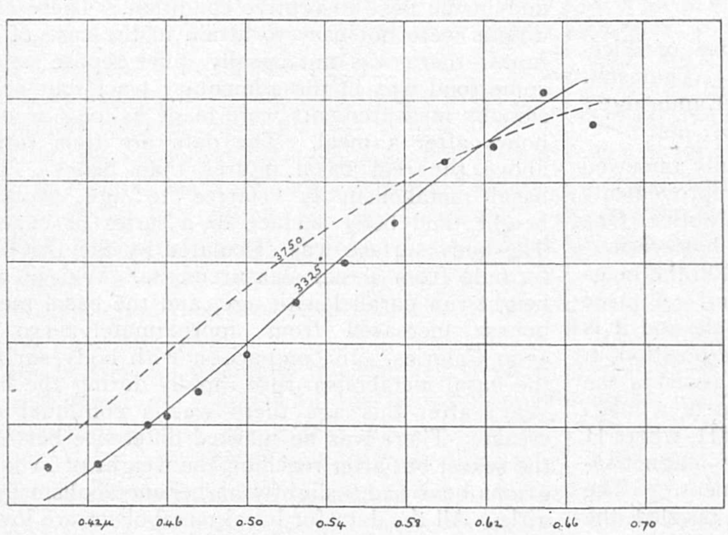


FIG. 1.—Intensity distribution in spectrum of positive crater carbon arc.

When the initial difficulties had been overcome a series of eight spectra of the acetylene flame was obtained on Ilford panchromatic plates. At the same time five spectra of the positive crater of the carbon arc were secured, cored carbons being used with a current of 5·7 amperes. The heights of these wedge spectra were measured to two different densities at various wave-lengths by means of a simple form of microphotometer devised for that purpose. The two series of measures differed by less than 2 per cent. The final mean absolute intensities of the carbon arc for various wave-lengths are shown in Fig. 1 by black circles. The mean probable error of these intensities is 1·7 per cent., the mean probable error of a single plate being 5·7 per cent. These mean probable errors would be considerably reduced if the intensity at 0·675μ were not used, the intensity at this point being subject to large accidental errors on account of the rapidly changing colour-curve of the plate.

It will be noticed that the observed intensities depart considerably from the intensities computed on the assumption of black-body radiation at a temperature of 3750° Abs. (shown by the dotted curve). The use of the observed values of the intensity distribution gives results for stellar spectra more in accord with those obtained by previous observers. There is still outstanding, however, in the case of the sun a depression requiring further investigation.

Two hypotheses may be advanced to account for the observed intensity distribution:—

(1) The carbon arc radiates as a black body at a temperature of 3750° Abs., but there is an absorption band with its centre at 0·50μ, due possibly to the incandescent carbon particles in the arc flame. Coblentz has shown that at 2360° Abs. these carbon particles have an absorption band with centre at 0·60μ (Bureau of Standards, Scientific Paper No. 156, 1911). At the temperature of the arc flame this absorption band would suffer a shift to the violet, bringing its centre approximately in the observed place. The advantage of this hypothesis is that it is in accord with previous determinations of the arc temperature by such various methods as (*a*) the calorimetric method used by Violle, (*b*) the wave-length of maximum energy used by Lummer and Pringsheim, (*c*) Féry's determination from the total radiation, and (*d*) various determinations by optical pyrometers using an approximately monochromatic band in the red. This hypothesis is represented graphically in Fig. 1 by the dotted curve showing the intensity distribution of a black body at 3750° Abs. computed from Wien's law, so as to bring it into approximate agreement with the observed values from 0·600–0·675μ.

(2) The carbon arc radiates as a black body at a temperature of 3325° Abs. This hypothesis is represented by the full curve in Fig. 1, which fits the observed values fairly well. It can be brought into accord with previous work only by supposing that the commercial cored carbons used burned at a lower temperature than those carbons used by other investigators. Wanner has found differences of 200° depending upon the carbons used.

It is evident, if the carbon arc is to be used as a standard of intensity distribution for photographic spectrophotometry—and it is a very convenient standard—that its intensity distribution should be very carefully determined against a laboratory black body.

H. H. PLASKETT.

Dominion Astrophysical Observatory, Victoria, B.C., June 18.

The Discovery of Large Quartzite Implements of Rostro-carinate and Early Palæolithic Types in Uganda.

THROUGH the kindness of Mr. E. J. Wayland, of the Geological Department, Entebbe, Uganda, I have become acquainted with an important discovery, made by him in Uganda, of a considerable number of large quartzite implements of rostro-carinate and Early Palæolithic types. Mr. Wayland has asked me to publish my opinion of the cultural relationship of the specimens, of which he sends me drawings, to the beak-shaped implements found beneath the Red Crag of East Anglia, and I may say at once that there would seem to be little doubt that the latter, though possibly more ancient, are clearly "related" to the East African artefacts.

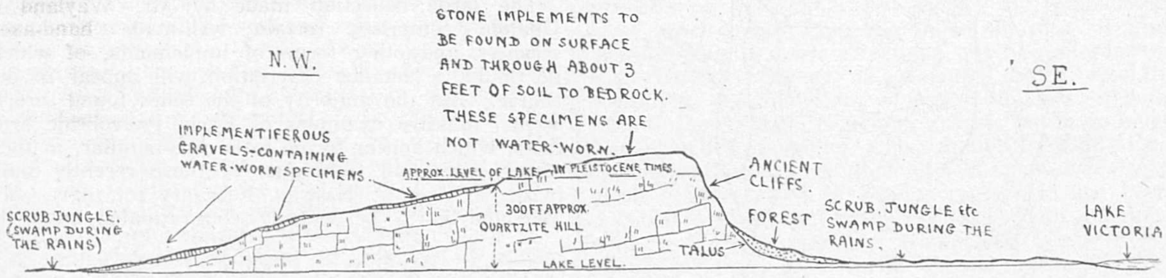
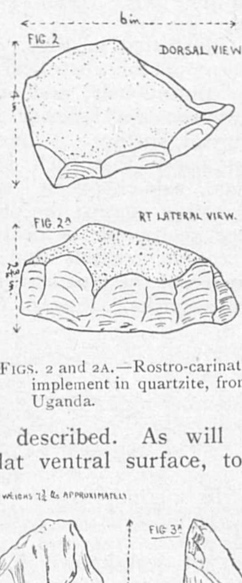


FIG. 1.—Rough diagrammatic sections (not drawn to scale) through Msozi Hill, Sango Bay, Buddu, Uganda.

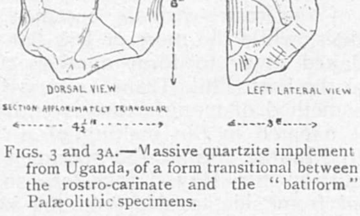
The exact localities where these new discoveries have been made are: (*a*) on the slopes and upon the summit of Msozi Hill, Sango Bay, Buddu, Uganda, and (*b*) at Kisiba, Tanganyika Territory. The accompanying diagrammatic cross-section (Fig. 1), copied from the drawing sent to me by Mr. Wayland, will make clear the positions in which the quartzite implements of Msozi Hill are found, and explain their discoverer's views as to the geological age of the specimens. As will be seen from an examination of Fig. 1, there are deposits of gravel on the slopes of Msozi Hill ("Quartzite Hill" of diagram) containing water-worn implements. On the summit of the hill, however, no gravel occurs, but Mr. Wayland finds upon the surface, and scattered through about 3 ft., of the soil, which there covers the bedrock, a number of specimens (of the same types as those found in the gravel) which are not water-worn. He observes, further, that the surface of Lake Victoria (shown to the right in Fig. 1) now rests at, approximately, 300 ft. lower than the level at which the unrolled implements occur, and he draws the conclusion that, when the people lived who fashioned the implements he has found, "Lake Victoria was 300 ft. above its present altitude, a state of things which, according to my showing, obtained during the Pleistocene Glacial period." It is thus clear that Mr. Wayland regards the quartzite specimens with which this letter deals as of considerable geological antiquity, a conclusion which, in my judgment, appears to be sound and in accord with the evidence he puts forward. From the numerous drawings of implements which have been sent to me, I have selected five which, while being representative of the majority of the implements figured, will, I think, enable me to fulfil Mr. Wayland's request that I should demonstrate the relationship of the Uganda specimens to the sub-Crag rostro-carinates of East Anglia.

The implement illustrated in Figs. 2 and 2A is, without any question, similar to many which have been found in the sub-Crag detritus-bed, and exhibits the characteristics of a broad, low rostro-carinate of primitive form, in which the keel, or carina, does not extend far back towards the posterior region of the specimen (Fig. 2A), and the dorsal surface (Fig. 2) is composed of unflaked "cortex." Figs. 3 and 3A illustrate a massive specimen—weighing approximately $7\frac{3}{4}$ lb.—which is somewhat similar in form to the



FIGS. 2 and 2A.—Rostro-carinate implement in quartzite, from Uganda.

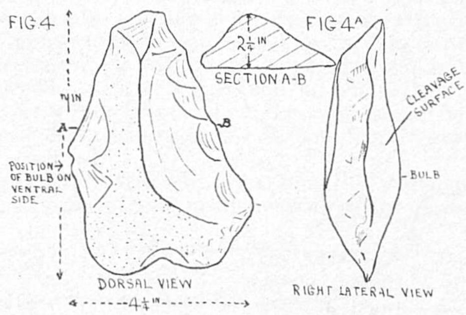
implement just described. As will be noticed, the more or less flat ventral surface, together with the



FIGS. 3 and 3A.—Massive quartzite implement from Uganda, of a form transitional between the rostro-carinate and the "batiform" Palæolithic specimens.

profile of the rostro-carinate form (Fig. 3A), is retained, but the dorsal surface (Fig. 3) is composed almost entirely of flake-scars, while the keel, or carina, is not a very marked feature.

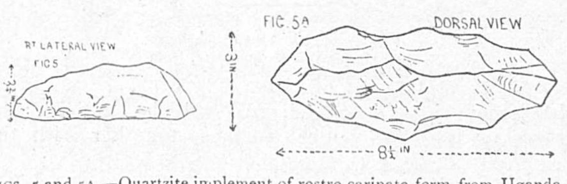
The implement illustrated in Figs. 4 and 4A is quite comparable, in its general outline and form, with that shown in Figs. 3 and 3A. Both these specimens, made from "chunks" of quartzite struck from still larger masses, are of great interest and importance as showing a transitional stage between the typical rostro-carinate form, with its prominent and functional keel, and the "batiform" Palæolithic implement, in which, while the simple triangular section is retained, the keel has become "depressed" and almost obliterated, thus ceasing to have any functional purpose. I have already described how, by the gradual "depression" of the carina, the rostro-



FIGS. 4 and 4A.—M ssive quartzite implement from Uganda, of a form transitional between the rostro-carinate and the "batiform" Palæolithic specimens.

carinate developed into the "batiform" implement of Early Palæolithic times (Phil. Trans., series B, vol. ccix., 1920).

The specimen illustrated in Figs. 5 and 5A represents another form of the rostro-carinate, in which the keel extends continuously, and approximately, in the middle line, from the anterior to the posterior region of the dorsal surface. I have suggested in my Phil. Trans. paper that such specimens might have been used as "side-choppers," the more or less flat ventral area resting against the palm of the hand, while the prepared keel would be utilised as a cutting edge. It is, of course, possible that, in addition to such use, implements of the type shown in Figs. 5 and 5A might be used as picks. Figs. 6, 6A, and 6B illus-

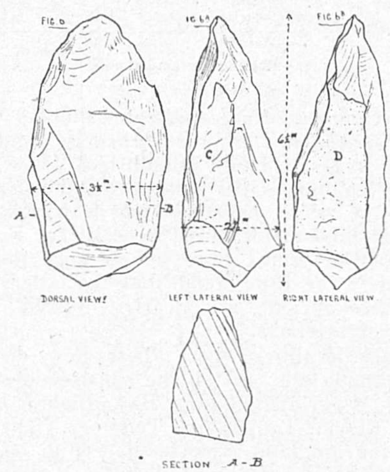


FIGS. 5 and 5A.—Quartzite implement of rostro-carinate form from Uganda, in which the keel extends over the whole length of the dorsal surface.

trate a specimen of well-known Early Palæolithic type, to which, at the suggestion of Sir Ray Lankester, I have given the descriptive name "platessiform." In this form of implement, in which the keel of the rostro-carinate becomes one of the cutting edges, while the more or less flat ventral surface is flaked away to form another cutting edge opposite to the keel (Phil. Trans., series B, vol. ccix., 1920), the method of manufacture is entirely different from that adopted in the making of a "batiform" implement. In the former the specimen is, as was pointed out by Sir Ray Lankester, so to speak, *compressed* from side to side, and the keel retained as a leading feature in its development, while in the latter the implement is, as it were, *depressed*—from above downwards—and the keel becomes functionless. The specimen illustrated (Figs. 6, 6A, and 6B) is of interest as showing, as do so many Early Chellean implements of similar form found in this country, the retention of portions of the original striking platforms (C and D in Figs. 6A and 6B), the dorsal and ventral surfaces of the ancestral rostro-carinate form.

From the above description it will be seen that I am of opinion that the specimens found by Mr. Wayland in Uganda are "related" to the rostro-carinate implements found beneath the Red Crag of East Anglia. It is clear, also, that the method of manufacture adopted in the case of these Uganda specimens is the same as was followed by the Early Chellean people living in this part of the world, and described by me in the Phil. Trans. paper quoted above.

The large collection made by Mr. Wayland in Uganda comprises certain well-made hand-axes, scrapers, and other forms of implements, of which, no doubt, a detailed description will appear in due course. But the majority of the relics found are, it seems, massive examples of Early Palæolithic artefacts, which appear to me to be very similar, in their forms, size, and technique, to those recently found by me at Cromer (NATURE, February 10, 1921). Mr. Wayland is to be warmly congratulated upon the



FIGS. 6, 6A, and 6B.—Quartzite implement of Early Palæolithic "platessiform" type from Uganda, showing portions of the original striking platforms retained (C and D in Figs. 6A and 6B).

important discovery he has made, which throws a new and welcome light upon the antiquity of man in Uganda. The outlines of the implements figured are not drawn to any special scale, but the approximate dimensions are indicated by the side of each drawing.

J. REID MOIR.

One House, Ipswich.

Measuring with High Powers of the Microscope.

UNDER a high power it is extremely troublesome to move the object so that one of its boundaries coincides exactly with a division of the micrometer-scale. But when the object is small this very greatly increases the accuracy; otherwise two estimated fractions of a division may constitute the greater part of the length measured.

Coincidence may be effected easily and with great exactness by gentle lateral pressure from the tip of the finger on the tube of the microscope; in this way the boundary of a well-defined image can easily be made to bisect a black line on the micrometer. If a micrometer with lines 60μ apart be used over a 2-mm. objective with No. 8 eyepiece, each division represents $0{\cdot}7\mu$, and a fifth part of a division corresponds to only 1/175,000th of an inch on the slide, which is therefore at the tube's centre the extent of the necessary distortion for bracket and bearing. The original position is recovered completely when pressure is removed. Probably everyone who uses high powers of wide angle has acquired the habit of effecting similarly extremely fine adjustments of focus by pressure on the stage.

With a lower power it is often helpful to press slightly on the nosepiece instead of moving the slide. For quick, rough measurements in the course of other work Prof. Dixon's "ghost micrometer" is very valuable (my friend Dr. W. R. G. Atkins introduced me to it). When the light is taken from a window the image of a piece of wire-gauze leaning against the pane can be brought on the object by a turn of the mirror, and removed again without losing sight of the object.

It may be worth adding that in measuring a distance in the line of sight (thickness) by the scale on the fine adjustment, one notch of the milling on the fine-adjustment head corresponds in my Zeiss to 1/10th of a division, or to 1μ ($1{\cdot}5\mu$ with a dry objective). The notches can be read opposite the pointer through a lens, with a probable total error of $0{\cdot}4\mu$ for the single measurement of thickness.

In measuring the width or thickness of a calcite spicule the optic axis of which is parallel to the plane of the slide, or in examining an object above or below the spicule, greater accuracy can be obtained by placing on the ocular a Nicol with the plane of polarisation at right angles to the optic axis of the spicule, so that the high refraction of the ordinary ray is abolished. Ebner (*S. B. Ak. Wiss.*, Vienna, vol. xcv., p. 73) recommended to spongologists the use of the single Nicol for determining the direction of the optic axis of spicules.

Interference-colours between Nicols.—The measurement of thickness in these sponge-spicules is very difficult, and I hope to substitute for it the mere reading of the spicule's colour between Nicols. Empirically, the colour of all but the two "limbs" of the cylinder appears to be closely that of a calcite plate of equal thickness, and to be irrespective of the angular aperture of the objective (0·20 to 1·40) and of the presence or absence of an Abbe condenser between the polariser and the object. These are, to me, unexpected results in view of the much longer path in the spicule taken by the ordinary ray as compared with the almost unrefracted extraordinary ray. As it is difficult to exclude a 5 per cent. error from determinations of either the thickness or the retardation, and as it has been disputed whether the carbonate of lime in a spicule be wholly calcite, I shall be very grateful if a physicist will supply the theory of the colour of a cylinder (elliptical or circular) of calcite in Canada balsam. The diameter of the cylinder ranges upwards from a wavelength of light to 10μ or so; the lowest Δ I have determined accurately is $134 \pm 4\mu\mu$ for the middle band of a spicule, which is a right cylinder since its optic axis is parallel to its length, and the width of which is $830 \pm 40\mu\mu$.

GEO. P. BIDDER.

Cambridge, July 10.

Ocean Tides.

IN the letter in NATURE of May 26 (p. 393) under the above heading, by Mr. H. A. Marmer, of the U.S. Coast and Geodetic Survey, it is pointed out that tidal observations would be greatly enhanced in value if permanent bench-marks were established in connection with them, not only for the correlation of any future tidal observations at the same places, but also for the determination of the rate of elevation or subsidence of the land relatively to the sea.

It may be of interest to note that this question was taken up some fifteen years ago by the Academy of Sciences of Paris, when a prize was offered for the best determinations of mean sea-level from tidal observations in any country bordering on the North Atlantic as a basis for such relative change in elevation on its coast-line. This prize was awarded to the present writer as superintendent of the Survey of Tides and Currents in Canada, as it was found that we had already tidal data available for this purpose, because referred to permanent bench-marks, on an extent of eight degrees of latitude from southern Nova Scotia to Belle Isle Strait.

Although this survey was primarily organised in the interests of navigation, its practice of establishing local bench-marks from the outset in 1894 is also bearing fruit in other directions. It has afforded to the Geodetic Survey of Canada, more recently organised, determinations of mean sea-level on both Atlantic and Pacific coasts as a basis ready to hand for extended levelling throughout Canada. Our Geological Survey also refers its contoured maps to mean sea-level, and in several regions it has been possible to give that survey an independent starting-point for these contours from tidal observations already obtained at a locality in the region, as they were referred to a local bench-mark.

As it is not often that the same superintendent remains in charge of a survey for so long as twenty-seven years, it may be allowable to give these examples in our experience of the advantages of the practice recommended by Mr. Marmer, which may accrue years afterwards.

W. BELL DAWSON.

Ottawa, Canada, June 22.

American and British Superannuation Systems.

THE writer of the leading article on this subject in NATURE of June 30 may have misled your readers by the last paragraph but one in his article, because :—

(1) No money can go into the pockets of shareholders of mutual insurance companies; there are no shareholders.

(2) If an endowment assurance is taken under the Federated System the benefits are increased by the share of profits, which, in the case of a mutual company, means a full share of all profits made.

(3) The expenses of the selected insurance companies are probably little more than those necessitated by a separate "association" when we bear in mind that the premiums charged under the Federated System allow for the saving of "commission to agents" by those offices that usually employ agents.

(4) The Federated System obtains the advantage of the experience of insurance companies in investing money expeditiously on a large scale.

The objection quoted as having been made by Mr. Fisher on the second reading of the School Teachers (Superannuation) Bill, 1918, to the effect that public money would go in "dividends to the shareholders" is met by (1) and (2) above. The real difficulty of placing his pension arrangements in the hands of insurance companies is that they cannot assess the invalidity risk or the future salaries on which the pensions in the Bill depend. The invalidity risk, the future salary scale, and the longevity of pensioners have necessitated far heavier contributions to pension funds than had been expected when the funds were started, and the difficulty of keeping private pension funds in a solvent condition is so well known to actuaries who have practical experience of them that the writer of the article may have thought it too obvious for reference. It is, however, an important aspect of the problem of providing pensions which ought not to be overlooked.

W. PALIN ELDERTON.

Mansion House Street, E.C.2, July 4.

[THE insurance companies selected by the council of the Federated Superannuation System are not all mutual companies, and, in consequence, there are shareholders and dividends to be taken into account. Apart from this, even among mutual companies such matters as directors' fees, palatial buildings, and highly paid officials are not unknown, not to speak of expenses, often heavy, of advertising. If Mr. Elderton wishes to maintain the position that insurance companies are purely philanthropic institutions, we fear he has taken on an impossible task.—ED.]

Cup and Ring Markings.

MAY I query Mr. Carus-Wilson's opinions in his letter in NATURE of June 23 (p. 523)? I have, alas! seen only one case (at Ilkley) of these markings, but have long been interested in the peculiar weathering of mortar which is common on the north side of old buildings near the sea. My view is that it is quite distinct from the cup and rings. The change in mortar is, I suspect, one of adsorptive precipitation, so well explained by Mr. S. C. Bradford in NATURE of March 23, 1916, and elsewhere.

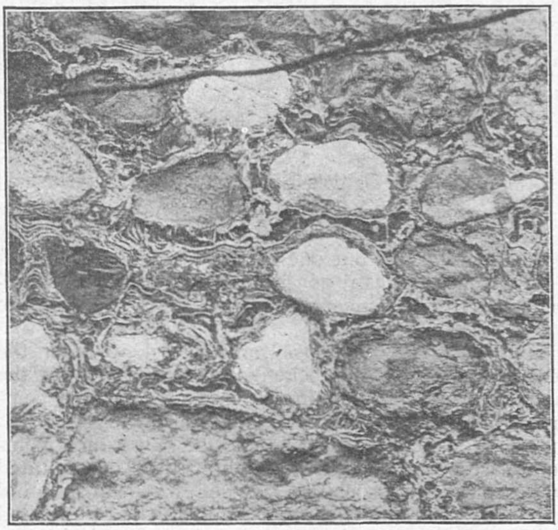


FIG. 1.

After saturation by rain, when drying takes place the lime forms into parallel lines with intermediate spaces, and those sand-grains which are thus robbed of their cement are speedily removed by the wind. The accompanying photograph (Fig. 1) is of an old stable wall built of local sandstones and limestones at the Military Arms Inn, The Nothe, Weymouth, and was taken in 1904. The scale is 1/10. I presume the cracks, etc., in old oil paintings are also quite unlike either of the above.

GEORGE ABBOTT.

June 26.

A New Acoustical Phenomenon.

WITH regard to Dr. Erskine-Murray's observation of the behaviour of aeroplane sounds (NATURE, June 16, p. 490), attention may be directed to the fact that any combination of confused noises will behave in the same manner, such, for example, as the noise of rustling leaves, escaping steam, a shower of rain on trees or tin roofs, or of a distant train in motion. If one stoops towards the road or approaches a reflecting wall while any of these noises are going on, the pitch of the sound rises, and when one is in the act of standing up, or of withdrawing from the wall, it descends. The grating of carriage-wheels on the road, or rather the noises reflected downwards from the body of the carriage, have a like effect when the observer is standing perfectly still. In this case, however, for some reason not clear to the writer, careful listening shows that the pitch falls as the vehicle nears the observer, and rises as it recedes from him. If the sound is a single continuous note, such as that of a whistle blown by a bicyclist riding past the observer, beats are heard as the whistle advances and also as it recedes, these being due to interference between the direct sound-waves and those reflected from the road. The occurrence of beats in such circumstances is perhaps not generally recognised.

F. M. WEST.

11 Downshire Square, Reading, July 12.

Magnetism and Atomic Structure.

ON the cubical atom theory developed by Lewis and Langmuir it appears that the molecules of CO_2 and N_2O have almost identical electron configurations. A. O. Rankine has shown from viscosity data that each electron system is equivalent to that of three adjoining neon atoms in line. The writer is not aware that attention has been directed to the fact that the specific susceptibilities of gaseous CO_2 and N_2O are $-0{\cdot}423\times10^{-6}$ and $-0{\cdot}429\times10^{-6}$ (Také Soné, Science Reports, Tôhoku, vol. viii., p. 162, 1919, and Proc. Phys. and Math. Soc. Japan, vol. ii., p. 84, 1920) and their molecular susceptibilities $-18{\cdot}6\times10^{-6}$ and $-13{\cdot}8\times10^{-6}$ respectively.

The electron systems of the two molecules are apparently identical, but the net positive charges on the atomic nuclei are 8–6–8 for CO_2 and 7–8–7 for N_2O. If, therefore, atomic nuclei possess rotations and are a source of magnetic moment, it must be assumed that the redistribution of the positive charges in the manner indicated involves no change of angular momentum.

A. E. OXLEY.

Shirley Institute, Didsbury, Manchester, July 14.

An Algebraical Identity.

WITH reference to the letters in NATURE of June 9 and July 7 by Dr. G. B. Mathews, Dr. H. C. Pocklington, and the Rev. J. Cullen on the polynomials $Y(x)$, $Z(x)$ satisfying the identity

$$Y(x)^2-(-)^{(p-1)/2}Z(x)^2=4(x^p-1)/(x-1),$$

may I point out that $Y(x)$, $Z(x)$ are tabulated as far as $p=101$ in Dr. Hermann Teege's inaugural dissertation, "Ueber die $\frac{1}{2}(p-1)$ gliedrigen Gaussischen Perioden" (Kiel, Peters, 1900)? Connected with these polynomials there is a further point which, so far as I am aware, has not yet been settled. When $x=1$ and $p\equiv1$ (mod. 4), $Y(x)=py$, $Z(x)=z$, and $py^2-z^2=4$.

I have verified from Dr. Teege's results that (y, z) is the primitive solution of $pu^2-t^2=4$, and consequently $\frac{1}{2}(z+y\sqrt{p})$ the primitive unit of the quadratic field $[\sqrt{p}]$ as far as $p=101$; but the question whether this unit is always primitive needs further investigation.

W. E. H. BERWICK.

The University, Leeds.

The Air and its Ways.[1]

By SIR NAPIER SHAW, F.R.S.

THE physical problems of the weather map have not been solved, for the subject is inherently difficult. In the first place, the atmosphere is on such an immense scale that its behaviour is not to be brought under the principles of physics without much trouble, and, I may add, many mistakes. The most confident theories of the past are flatly contradicted by facts which have come to light since the investigation of the atmosphere was extended to the upper air by balloons, kites, kite-balloons, and more recently by airships and aeroplanes. We have now many facts about the atmosphere up to 20 kilometres at our disposal. They are, of course, not necessary for the formation of a correct theory, because no new principles are involved, but they are invaluable for the purpose of the verification or contradiction by which hypotheses get moulded into consistent theory.

The behaviour of air in bulk is so entirely different from that of the laboratory sample that the ways of the air are, indeed, as peculiar as those of "the heathen Chinee." The air as we know it in the laboratory is a very mobile fluid, yet in the atmosphere it manages to take on a sufficiency of the character of an elastic solid. It does not go in the way it is pushed; pushed north it goes east, and pushed east it goes south. The condition for getting it to go north is that it should be pushed west. If you blow a jet of air straight upward you may find that part of the effect is a vortex whirling around you. In front of its fire—the sun—the air will very likely get colder instead of warmer; losing heat by exposure to the clear sky on a cold night, it may get warmer. In spite of all that is taught in the laboratory about the levitating effect of warmth, cold air floats above us with warmer air beneath. If you tell the air that warm air rises, it winks an eye and interjects an "if" and a "when." If the Olympian gods felt cold and thought to make themselves warmer by stirring up their chilly air with the warmer air enjoyed by mortals down below them, they would be disappointed. Stirring would make them colder and us warmer. Shake air up violently, water falls out of it; and if the shaking went on long enough the air would become intolerably dry, very cold at the top and very warm at the bottom. Not only has the air the innate capacity for these conjuring tricks, but it never, or scarcely ever, fails to use them.

The General Problem of the Science of Meteorology.

Yet, underlying the work that is done in meteorology officially or unofficially, there is, and has been all the time, a definite purpose to bring our knowledge of the air into relation with the laws of physics as established in the laboratory, and, therefore, particularly with the laws of energy.

The Fundamental Facts.

There are two sides to the study of the air and its ways which can be pursued by different people who may never meet each other. One is the observation and collection of the facts about the weather from every part of the world; the other is the interpretation of facts by dynamical and physical reasoning. Nothing—at least nothing useful—can be done without real facts; but real facts do not, as a rule, explain themselves. The composition of air at different levels has been computed, and the results for one hundred kilometres are different according to Humphreys, Wegener, and Chapman. Below the level of 20 km. we are not troubled with changes of composition except those in the amount of water-vapour. The meteorological facts may be expressed by maps showing coast lines and orographic features, surface-temperature in January and July and its discontinuities at the coast lines, water-vapour at the surface in July, cloud, rainfall over the land, winds over the sea, and pressure over the globe in the same month.

Winds and temperatures in the upper air can be illustrated by models in cardboard. That for temperature shows the general run of the isothermal surfaces and the modifications caused by the introduction of local cyclones and anticyclones.

The Atmosphere a Great Steam Engine.

We are all agreed that the atmosphere is in reality a great engine, partly an air engine, but more effectively a steam engine, or at least a moist-air engine. Now the essential parts of a steam engine are a boiler to supply it with heat, a condenser at a lower temperature to absorb the surplus heat, and a fly-wheel to maintain the continuity and uniformity of its action. We describe the action of the engine as taking a supply of heat from the boiler, giving out heat to the condenser, and converting into work, useful or otherwise, the difference between the heat taken in and that given out.

Can we rightly use such language about the atmosphere and usefully contemplate the ways of the air from that point of view? I think we can, though the analysis of the phenomena from that point of view is difficult. The boiler is certainly there; I have shown it to you in the distribution of temperature with the great warmth of the equatorial regions. In the map of the distribution of water-vapour I have shown you where the steam is raised. The condenser is there also, partly in the shape of the vast cooling surfaces of the high lands of the arctic and antarctic regions, and of snow-covered mountains generally; but perhaps more effectively in the upper air, particularly in the stratosphere, which at a temperature of

[1] Abridged from the Rede Lecture at Cambridge on June 9.

190a. to 240a. (*i.e.* from 60 to 150 Fahrenheit degrees below freezing point) is certainly cold enough for the purpose, and, for certain reasons which I will not now expound, must be regarded as an effective means of getting rid of heat by radiating it into space.

The Fly-wheel of the Atmospheric Engine.

And what of the fly-wheel and the work done by the engine? Surely the winds, whether of the general circulation or of the local circulation of cyclonic depressions, are a fair representation of the fly-wheel. At the risk of laying myself open to the unpardonable sin of punning, I will point out that the fly-wheel is of enormous importance to flying, because the flyer can either attach himself to it and be carried along with it, or he may have to labour to make headway against it. The choice of these alternatives depends upon the airman's knowledge of its habits and behaviour—of its ways, in fact. The constituent parts of the fly-wheel at any time are the natural air-ways of the world. It was by hanging on to one part of the fly-wheel in the fifteenth century that Columbus discovered America, and by the aid of another portion, just two years ago (June 14, 1919), Sir John Alcock crossed the Atlantic in 16½ hours, and on July 13 of the same year Air Commodore Maitland landed R.34 at Pulham after a journey from New York in 3 days and 3 hours. Its total energy is tremendous, of the order of 100 billion horse-power-hours.

The Polar and Equatorial Circulations in the Upper Air as Parts of the Fly-wheel.

One of the immediate results of the thermal operations is to maintain the great fly-wheel or to start new sections of it in the form of local cyclonic circulations. Omitting these for the moment, I want to put before you some information about that part of the fly-wheel which is expressed by the general circulation. We can do so by distinguishing and ultimately isolating those portions of the atmosphere which represent permanent parts of the general circulation. Our best method of procedure is by way of pressure. We can compute the distribution of pressure for successive levels and verify the computation by the occasional observations of pressure at the various points of observation. We can thence calculate winds to correspond therewith in accordance with the general principle of the relation of pressure to wind, to which reference has already been made, and which finds partial expression in Buys Ballot's law.

A glass model expresses the results most clearly. It is made to show simultaneously on concentric hemispherical glass shades maps of pressure for 2000, 6000, and 10,000 metres. They disclose an enormous body of air extending at the higher levels from the pole or thereabout to latitude 40°, with a protuberance to the equator in the lower levels of the monsoon region. The air circulates about the polar axis in curves not exactly coincident with circles of latitude, but not very different therefrom. This mass of moving air constitutes a very considerable fly-wheel.

The maps also disclose a collection of anticyclonic circulations in the intertropical region lying between a stream of westward-moving air at the equator and a stream of eastward-moving air at about latitude 35°. Thus the margins of the anticyclones form a sort of chain-drive pulling the air from east to west on the equatorial side and pushing the polar circulation eastward. These vast local areas of high pressure are interesting in relation to the tracks of hurricanes, the normal path of which for this part of the year is marked thereon. The lines which separate the high-pressure areas are at the coast lines, and emphasise the meteorological importance of those lines; with one of them the hurricane track is evidently associated.

Local Cyclonic Circulations as Parts of the Fly-wheel.

Among the products of the working of the aerial engine we have included the energy of the circulation of local cyclonic depressions, whether they take the form of the hurricanes of tropical countries or of the milder depressions of our own latitudes. I anticipate no objection to the suggestion that these phenomena are part of the working of the general atmospheric engine; but there is so far no general agreement as to the precise way in which the engine operates to produce these results.

I have recently suggested that the development of a vortex of revolving fluid may be due to the "injector-effect," or, as I prefer to call it, the "eviction-effect," of rising air or falling rain or both combined, and I have put together an apparatus designed to test the effect of the various possible causes in producing a cyclonic vortex when the conditions of relative motion are favourable. I have come to the conclusion that the air is much more easily moved to take up cyclonic circulation than has hitherto been supposed, and, in fact, cyclonic circulation is the natural expression of a part of the kinetic energy of rising air or falling rain, requiring only favourable local conditions for its obvious manifestation. Perhaps I may add that on that ground a volcano in explosive eruption ought naturally to cause a local tornado. The energy of cyclonic motion can therefore be added to the other parts of the atmosphere's fly-wheel with some confidence that it is in accordance with natural fact.

An Indicator Diagram for the Atmospheric Engine.

If this view of the atmosphere is a reasonable one, then we ought to be able to refer the operations of the air to what Maxwell calls an *indicator diagram*, expressing by the area of a closed figure the work done by the air in the course of a cycle of operations represented by the outline of the figure. During the past forty years I have been trying to get that diagram in continuation of the work that I used to do with a class at the Cavendish Laboratory, and now I believe I have succeeded, with the assistance of Mr. E. V. Newnham, of the Meteorological Office. The result is not exactly in the form which is familiar to readers of Maxwell, but in the form of an entropy-temperature diagram such as Sir Alfred Ewing uses in his work on the steam engine. With the diagram it ought to be possible to make a reasonable diagnosis of the ways by which air can ascend from the surface, and descend again to be prepared for a repetition of its cycle. We should then replace by reason the guesswork which has hitherto done duty for it. Further, according to the diagram, the best which you can expect from the steam-laden air of the equatorial region, working between the surface and the stratosphere under favourable conditions, is a "brake-horse-power efficiency of 25 per cent." Operations conducted elsewhere will have less efficiency than that. On the whole, it is not very high, but the energy available as indicated by the equivalent of the amount of rain which falls is so enormous that there is no reason to doubt the capacity of the air as a steam engine to develop and maintain the effects which are included in all our varied experience of the air and its ways.

Congress of the Universities of the Empire.

THE second Congress of the Universities of the Empire, which met in Oxford on July 5–8, was as successful as the Congress of 1912. Higher tribute could not be paid to the skill of those who were responsible for its organisation. Thirty-seven overseas universities were represented by ninety-four delegates and twenty-two "representatives," of whom the very large majority had come to England for the express purpose of attending the Congress. The total number of members, including Oxford residents, was about 600. In the printed list we find amongst the delegates the chancellor of New Zealand, the ex-vice-chancellor of Calcutta; the presidents of Alberta, British Columbia, Dalhousie, McGill, Queen's, Kingston, Saskatchewan, and Toronto; the vice-presidents of Montreal and St. Francis Xavier; and the principals of the University Colleges of Pretoria and Johannesburg and of several Indian colleges. When the present cost of ocean travel is taken into consideration, these figures bear eloquent testimony to the belief of the universities of the Empire in their essential unity and to their faith in their common mission.

In one respect the Congress of 1921 far surpassed that of 1912 in attractiveness, and probably in value also. With the greatest generosity the members of the University of Oxford offered the hospitality of their colleges and their homes to all members of the Congress. The meeting together in common rooms and in the houses of their hosts gave great pleasure to the men and women who had come from the most distant parts of the King's Dominions. The opportunities thus afforded of intercourse and of informal discussion are likely to produce results more important in their bearing upon the practice of teaching and administration than the speeches made in the South Hall of the Examination Schools.

Opportunities of consultation and of the comparison of experience are being further enlarged by the application of a scheme of visits which was tried on a smaller scale and in a somewhat tentative way in 1912. For a month all delegates from overseas are the guests of the home universities. Before Congress met they were given the choice of visiting Reading, Bristol and Cardiff, or Dublin and Belfast. Returning to London, as the guests of the University, they visited its schools and colleges on June 30 and July 1 and 2. On July 4 the Government entertained them, together with the delegates of the home universities, at a luncheon over which Mr. A. J. Balfour presided. On the following morning they travelled by special train to Oxford, where the congress was opened by the chancellor of the University, Lord Curzon. From Oxford the delegates from overseas proceeded to Cambridge and thence to either Edinburgh and St. Andrews, or Glasgow and Aberdeen. They will return in three parties *via* Durham, Newcastle, or Sheffield to Manchester or Liverpool, and will end their tour either in Birmingham or in Leeds.

As the proceedings of Congress have been reported in the daily Press, it will suffice here to mention only some points of special interest to men of science. As was fitting at a meeting in Oxford, the first session was devoted to the consideration of the balance of studies—the place of the humanities in the education of men of science, and of the physical and natural sciences in general education. Many wise things were said by the champions of a literary education. Prof. Desch and Prof. Whitehead spoke for those concerned with the education of students of science. Prof. Desch urged the necessity of including a large measure of humanistic instruction and study in the training of men of science, but proposed that it should take a novel form. In place of balancing the specialised courses in science by a certain number of equally specialised courses in the humanities, he would endeavour to bring the two into closer relationship by making the teaching of science historical, literary, and sociological. If scientifically trained men are to take their proper position in the community they must have "a vision of knowledge in its true proportions and perspective." "The most important safeguard against a limited vision is to be found in the historical spirit." Teachers should show to their students how their sciences grew, should interest them in the lives of their founders and chief exponents, and, in favourable cases, in their original writings. In pure science the student should be shown how each discovery was related to the state of intellectual development at the time when it arose; in technology the opportunity should be taken of bringing discoveries and inventions into relation with the events of history and with the condition of society at different periods. The training of a scientific man could not, as a rule, include the study of dead languages; but modern scientific thought has its roots in ancient Greece.

Prof. Whitehead dealt with the preparation of schoolboys for scientific study at the university. "The main structure of successful education is formed out of the accurate accomplishment of a succession of detailed tasks." This must be ever kept in mind, since the enthusiasm of reformers so naturally dwells on "the rhetoric of education." The cynic is apt to proclaim that it does not make much difference what the detailed tasks may be; the one important thing is to get children into the habit of concentrating their thoughts and of doing what they are told. On the contrary, the wise selection of the detailed tasks is of prime importance. "Every subject in the preliminary training must be so conceived and shaped as yielding, during that period, general aptitude, general ideas, and knowledge of special facts, which, taken in conjunction, form a body of acquirement essential to educated people. Furthermore, it must be shown that the valuable part of that body of acquirement could not be more easily and quickly gained in some other way by some other combination of subjects." The hard element in a scientific curriculum consists in the attainment of exact knowledge based on first-hand observation. The soft element comprises two factors, of which the more important is browsing, with the very slightest external direction, and mainly dependent on the wayward impulses of a student's inward springs of interest. The second factor should consist of descriptive lectures, designed for the purpose of exciting general interest in the various sciences.

The afternoon session on July 6 was devoted to the consideration of "The Universities and Technological Education." Lord Crewe, the chairman, sounded the keynote of the discussion. No longer is it a question as to whether the universities should or should not provide training of the type defined as technological, but as to how far they should go in promoting studies which lead men and women on to employment in the fields of industry and commerce, or engage them in continued scientific research. "The universities exist because they satisfy the needs of the country—moral, intellectual, and practical—and the nature of the teaching they supply is conditioned by those needs. When, therefore, the conductors of an increasing number of industries assert that their methods depend for development and practical success upon scientific knowledge, and that it is only from the appropriate departments of different universities that such knowledge is forthcoming at its best, the universities have no choice." Lord Crewe directed attention to the outstanding success of the schools of agriculture of the two ancient universities.

Sir Arthur Currie gave an account of the highly organised courses for engineers at McGill. These courses extend over four sessions, and include economics, finance, and industrial law. During the three intervening summers students obtain practical experience in works. In virtue of their superior education, they are fitted, when they go into the active practice of their profession, to rise to positions in which they will lead and direct. Advanced courses in which students are taught how to conduct investigations are also arranged, the Canadian Government providing forty-five scholarships for graduates who show aptitude for research.

In the course of an able paper Prof. Smithells said: "I have always thought that our difficulties with technology have arisen chiefly from the belated and stinted cultivation of natural science in the ancient universities." "If natural science as it arose had been gathered to the older studies and had flowed in its natural courses, the mechanical arts and those who follow them would surely have been brought long since into a very different relation with the academic world." "It would be excusable, perhaps, to make this the occasion to preach the urgency of technology. But that is not my intention; I am far more anxious to raise my voice against its unbridled pursuit, to direct attention to the restraints under which it should be fostered, and to plead for what seems indispensable to its worth." Of the Department of Scientific and Industrial Research his experience led him to say: "I hope I exhibit some capability of seeing what is good in this new State Department. Of what appears not good I will only say this, that there seems most room for anxiety in the creation of isolated institutes for technological research, which may detach from universities a most valuable type of studies and of men that will themselves suffer from their isolation."

Mr. J. C. Maxwell Garnett contended that "the provision of the highest technological education by universities, instead of by separate institutions, tends also to benefit the industries by harmonising the ideals and purposes of leaders of the people in many different walks of life, by widening the interests of the future captains of industry, and by accustoming them to an atmosphere of scientific inquiry, so that in due course they will encourage research, well understanding that research is something more than experimental tests—more even than attempts to discover immediate industrial applications of established facts."

Prof. W. W. Watts, after sketching the purpose of technological education and the aims of the universities and other institutions which set themselves to prepare men for industrial life, said: "The scheme of education that will be evolved . . . will not greatly differ in its method from the older forms of literary or scientific learning, nor will its value be less as an instrument for equipping the intellect and training the mind." On the subject of touch with industry, he continued: "Until the student knows some of the features of the industry in which he will be engaged, he finds it difficult to realise the significance of many parts of his training. . . . In my opinion, the advantages of early touch outweigh its disadvantages." "The type of men which it should be the aim of the universities to turn out . . . must be willing to study all the conditions of their problems before they are sufficiently satisfied with their solutions to carry them into effect. These conditions require, not a solution, but the solution which can be brought into operation with the least possible disturbance of the things that are, without needless change of raw material, machinery, or *personnel*, but with the advantage of diminished cost, enlarged production, and increased value or efficiency."

Presiding over the morning session on July 8, which was devoted to the consideration of "The Universities and Research," Lord Robert Cecil spoke of his friendship with Lord Rayleigh and of his astonishment at the freshness with which he retained until the last days of his life his interest in the advance of knowledge.

After a paper by Sir Frederic Kenyon on humanistic research, and one by Prof. Firth on historical research and university teaching, Prof. Joly spoke on scientific research. He recalled the fact that it was in Oxford that the Royal Society, the greatest of research societies, had its origin in the endeavours of such diverse spirits as Wilkins, Boyle, Wren, Seth Ward, and Wallis. "The argument for research in universities rests upon the broad basis of the value of the intellectual progress of mankind. I think I am correct in saying that most men who have adopted a life of research, or have made research the object of their special interest, have acquired their intellectual ideals in the days of their college life." If his teachers are without interest in research, the enthusiasm to create new knowledge is not implanted in the student. "Perhaps the most striking feature of American universities, as viewed by the British visitor, is the prevalence of research, and the lavish provision made for its prosecution. It extends into every branch of university work." "The American recognises to the full the value of the mental attitude induced by research, and this recognition is not confined to the university professor, from whom it may be expected, but extends, so far as I could gather, everywhere throughout the States."

The discussions of the Congress, which were carried on with great vigour, are likely to prove fruitful in the minds of those who heard them. The permanent, and perhaps more important, outcome will be the full Report of the Proceedings of the Congress, which will be published by Messrs. G. Bell and Sons in the autumn.

Gold Medal of the Royal Society of Medicine.

AWARD TO SIR ALMROTH WRIGHT.

AT the recent annual meeting of the fellows of the Royal Society of Medicine the president, Sir John Bland-Sutton, announced that the recently founded gold medal of the society had been awarded to Sir Almroth Wright in recognition of the value of his important contributions to medical science, and particularly of those made during the war. Unfortunately, Sir Almroth Wright, who had been compelled to go abroad, was unable to be present, but had written very cordially thanking the council of the society and expressing his great appreciation of the honour bestowed upon him. In his absence, the medal was handed to his brother, Dr. Hagberg Wright.

The council of the society was enabled to institute the gold medal by the generosity of the late Dr. Robert Murray Leslie, who transferred to the society investments in perpetual trust for the purpose. The trust deed provides that the medal is to be awarded every three years, and is hereafter to be presented on St. Luke's Day (October 18) to a scientific worker, man or woman, who has made valuable contributions to the science and art of medicine. It was specially provided that the first award should, if possible, be made for original or other work in connection with military medicine and surgery which had proved of value during the Great War.

The council of the society felt that for such an award an effort should be made to produce a medal which, in art and symbolism, should be worthy of the occasion, and upon the advice of Mr. G. F.

Hill, keeper of the medals in the British Museum, the work was entrusted to Mr. Carter Preston, who has produced the beautiful design shown in the accompanying reproductions of photographs.

The obverse shows Hygieia, daughter of Æsculapius, placing a wreath upon a figure kneeling before her holding a lamp, signifying Research. The reverse shows the centaur Chiron instructing the young Æsculapius in the elements of medicine.

Obituary.

Henry Rondel Le Sueur.

HENRY RONDEL LE SUEUR was born on January 1, 1872, the son of F. C. Le Sueur, of Trinity, Jersey. He attended a private school until 1887, and then for two years was in the laboratory of a Jersey analyst, Mr. F. W. Thoms. Thence in 1889 he proceeded to University College, London, taking the B.Sc. degree of the University of London (Honours in Chemistry) in 1893, and the D.Sc. degree in 1901.

Le Sueur's teaching experience was entirely connected with one institution—namely, the Medical School of St. Thomas's Hospital, where he was appointed demonstrator in 1894, and lecturer in 1904, a post which he was holding at the time of his death on July 9. There was but one break in his connection with the hospital—namely, that caused by the war. In July, 1915, he was commissioned major in the Royal Engineers, and ordered to Gallipoli to advise on chemical warfare problems, and the complaint which he contracted there was probably in no small degree responsible for his final illness. On his return to England he was one of those originally appointed to the Gas Warfare Experimental Station at Porton, Wilts., where he remained until the end of 1917, when he was ordered to the United States to assist in the preparation of the American Gas Warfare Experimental Station.

Le Sueur was one of the secretaries of the Chemical Society, and most of his original papers are to be found in the society's journal. He was a most capable experimenter, who found it necessary to satisfy himself on the minutest detail. This probably accounts for the fact that the number of his communications (twenty-four) was not large, but they are characterised by a thoroughness which can be rightly appreciated only by those who knew his methods of work. It was, however, as a teacher that Le Sueur shone as a particularly bright star. His capacity for imparting knowledge to others was most pronounced and quite exceptional, and among his students in the laboratory he was at his best.

Le Sueur's most marked characteristic as a man was his unfailing loyalty, whether to the science of his adoption, to his colleagues and students, or to his friends. Certainly the island of Jersey never possessed a more loyal or truer son. His efforts to mask a natural shyness and reserve of manner did not always meet with the success which would allow strangers to recognise the true qualities of the man himself, but those who knew him intimately realise that by his untimely death the science of chemistry has lost a devoted servant, and they have lost a true and loving friend.

A. C.

WE notice with much regret the announcement in the *British Medical Journal* for July 16 of the death of SIR GEORGE SAVAGE on July 5 at the age of seventy-eight years. Sir George was educated at Brighton and Guy's Hospital, where he won the treasurer's gold medal. He received the degree of M.D. (Lond.) in 1867, and in 1878 he was elected to a fellowship of the Royal College of Physicians. For seventeen years—from 1872 to 1889—he was connected with the Bethlem Royal Hospital, and it was during this period that his reputation as a psychiatrist was established. In 1886 he was president of the Medico-Psychological Association, and in succeeding years he presided over the Neurological Society and the section of psychiatry of the Royal Society of Medicine when this section was founded in 1912. In the same year he received his knighthood. For a number of years he was co-editor with Dr. D. Hack Tuke of the *Journal of Mental Science*. In 1907 he was elected Lumleian lecturer of the Royal College of Physicians, and two years later he became Harveian orator, taking as his subject experimental psychology and hypnotism. Sir George published one text-book, "Insanity and Allied Neuroses," which has become a standard work, in addition to numerous papers contributed to both English and American medical journals.

WE record with regret the death of SIR HERBERT BABINGTON ROWELL, which occurred suddenly on June 23. Sir Herbert, we learn from *Engineering* for July 1, was born in 1860, and finished his professional education at Glasgow University, where he studied naval architecture under Profs. Elgar and Jenkins. After experience with various shipbuilding firms, he became manager of the Hebburn shipyard of Messrs. R. and W. Hawthorn, Leslie, and Co., Ltd., and in 1916 became managing director of this firm. Sir Herbert was the first lecturer in naval architecture at Armstrong College, Newcastle. He was also a member of the council of the Institution of Naval Architects, and a member of the Institution of Civil Engineers. From 1912 to 1914 he was president of the Shipbuilding Employers' Federation, and from 1915 to 1917 president of the North-East Coast Institution of Engineers and Shipbuilders. In addition he was a member of Lloyd's Technical Committee, and filled many other public appointments. He received the honour of knighthood in 1918.

IT is with great regret that we learn of the death of PROF. GABRIEL LIPPMANN, Foreign Member of the Royal Society, on July 14 on board the liner *La France* while on his way from Canada, where he had formed part of the French Mission under Marshal Fayolle. Prof. Lippmann was born in 1845 and educated in Paris. His work there was concerned mainly with the relation between electrical and capillary phenomena, the outcome of which was his capillary electrometer and other instruments. His process of colour photography, announced in 1891, is widely known. In 1908 he was awarded the Nobel prize for physics, and in 1912 became president of the Paris Academy of Sciences.

WE announce with much regret the death, on June 1, at the age of seventy-nine years, of MR. CHARLES PICKERING BOWDITCH, associate of the Peabody Museum of American Archæology and Ethnology, Cambridge, Mass. Mr. Bowditch was well known for his work on Mexican and Maya codices and inscriptions.

WE regret to announce the death of PROF. J. A. MENZIES, professor of physiology at Durham University School of Medicine, Newcastle-upon-Tyne.

Notes.

THE Civil List pensions granted during the year ended March 31, 1921, amounted to 1200*l*., and include the following:—Mrs. Frederick Enock, in recognition of her husband's services to natural science and entomology (September 7, 1920), 100*l*.; Mr. Edward Greenly, in recognition of his services in the geological survey of Anglesey (September 7, 1920), 80*l*.; Mrs. J. A. McClelland, in recognition of her husband's distinguished services as an investigator in physical science (September 7, 1920), 100*l*.; Mrs. and Miss Sharman, in recognition of Mr. George Sharman's valuable services in palæontological science (September 7, 1920), 80*l*.; Mr. John Nugent Fitch, in recognition of his long services to the cause of botany, horticulture, and natural history (September 15, 1920), 75*l*.; Mr. W. R. Hodgkinson, in recognition of his valuable scientific work in the public service (March 24, 1921), 100*l*.; and Mr. Herbert Tomlinson, in recognition of his services as a teacher, and of his valuable and distinguished contributions to physical science (March 24, 1921), 100*l*.

THE popular fallacy that explosions can precipitate rainfall found expression in the question asked by Major Morrison-Bell in the House of Commons on July 13 as to whether the Government would be prepared to initiate experiments which might possibly have the result of precipitating a downpour of rain. The answer given was to the effect that from past experiments meteorologists were of opinion that explosions would not induce a fall of rain, and rightly so; for experiments were conducted on a vast scale, not, it is true, with that particular end in view, on the Western Front during the Great War. The collation of statistics of rainfall with the gunfire failed to show any certain connection. The only way in which the water-vapour in the atmosphere can be condensed into rainclouds is by cooling. Unless an explosion can produce a cold current, or cause to any appreciable extent such a disturbance in the atmosphere as will bring about the mixture of a stratum bearing a cold current with that carrying a warmer current, it cannot produce rain. The compression in the air produced by a bursting shell is propagated as a sound-wave. The amplitude of the motion, therefore, diminishes as the square of the distance from the origin, so that at the distance of a quarter of a mile it would probably be no greater than 1/10,000th of an inch. In 1917 M. Angot, Director of the French Meteorological Office, showed that in the extreme case of two equal masses of saturated air, one at 0° C. and the other at 20° C., it would be necessary, in order to produce rain of even so small an amount as 1 mm. (0·04 in.), for the two masses rapidly and thoroughly to mix throughout an atmospheric layer of 6850 metres (about 4 miles) in thickness. Nor are dust particles and ions, which form the nuclei of raindrops, sufficient of themselves to cause precipitation unless there be a concomitant reduction of temperature.

BY a resolution of the Swedish Riksdag passed on May 18 last, it has been decided to establish an institute for the investigation of the problems of racial biology. To Sweden, therefore, falls the honour of being the first country to establish a State-supported institute of this kind. The history of the movement which led up to this decision is related in a pamphlet, written in English, entitled "The Swedish State Institute for Race Biological Investigation," which has just been published by Dr. Hjalmar Anderson. The success of the movement has been due largely to the indefatigable exertions of one man, Dr. Herman Lundborg, who was the first to direct attention in Sweden to the national importance of the study of eugenics in a lecture which he delivered to the Upsala Physicians' Society in 1904. After much strenuous advocacy on the part of Dr. Lundborg and other prominent men of science, the question was brought to the notice of the Riksdag, and a report was called for. As a result of the opinions then expressed, the Government took up the matter, and Dr. B. Bergvist, the Minister of Education, drew up a recommendation, which received the Royal sanction, in which it was proposed to found an institute with an annual appropriation of 80,000 crowns. In the meantime Dr. Lundborg, with a self-sacrifice worthy of all praise, had rejected an alternative proposal to establish a chair for him in Upsala University, on the ground that a subsidy granted to an individual gave no assurance for the continued study of the subject in the future. The Riksdag, therefore, although unable to adopt the full recommendation as to the appropriation in view of the present financial situation, decided, as already stated, to establish a State institute, of which Dr. Lundborg will be the director.

IN a letter referring to the leading article on "Internationalism" in NATURE for July 7, p. 577, a correspondent writes to urge the necessity for a deeper and wider investigation of this complex question. In this connection attention may be directed to a little book recently published by Prof. H. J. Fleure, entitled "The Treaty Settlement of Europe" (Oxford University Press, 2*s.* 6*d.*), in which the author examines the provisions of the settlement from the ethnographic and geographical aspects. In his introductory chapter, after an admirable survey of the historical development of the conditions of life in Europe, Prof. Fleure points out that the treaties, using a framework which is largely linguistic, have attempted to apply to Europe the idea of the sovereign nation-State as it has arisen in the West; whereas, he holds, the coincidence of nation and State has been by no means close east of the Rhine. His chief and most weighty criticism of the treaties is that they tend to perpetuate conditions, and in particular the linear frontier, which have too often led to hostilities and disputes. He maintains that frontiers are really broad zones, and, further, that our politicians have failed to realise fully and to work out the implications of the fact that "in Europe we can only have unity in diversity." Prof. Fleure is perhaps inclined to attach too little weight to racial and nationalist feelings in the peoples of eastern Europe. The racial spirit of the Serb and the nationalism of the Greek are intense and deep-rooted, while in the more stolid Bulgar both sentiments are strong, if less demonstrative. Further east, in the Caucasus, which is beyond Prof. Fleure's province, in the case of the three republics which resulted from the Treaty of Brest-Litovsk, two, namely, Georgia and Erivan (Armenia), were the expression of a popular desire for a national existence which lent support to the political ambitions of their leaders.

IN a letter to the *Times* of July 12 Mr. Robert Donald suggests that a corporation organised on commercial lines should be formed to conduct a general inter-Empire scheme for radio communication, the shareholders being the Governments of the States of the Empire, each represented in proportion to the capital it subscribes. The corporation should be directed by a small executive committee consisting of business men and engineers. The chain of radio stations could be built under contract, the corporation retaining ownership. The working of the system, however, should be leased to a company on attractive terms. In addition to directors appointed by the Governments, the British Radio Corporation should have on its board representatives of the Admiralty, War Office, Air Ministry, and Post Office. The advantages of this scheme are State ownership of an indispensable public service and private enterprise without monopolistic control. A company can also enter into international trade much more readily than can a union of States. The capital required for a few high-power stations with a working range of 6000 miles and low-power stations with a continuous working range of 2000 miles would not be great. The Compagnie Radio France has been constituted on somewhat similar lines. As the scheme is commercially feasible we hope that the Government will seriously consider it.

AN interesting ceremony took place a few days ago at Lacock Abbey, near Bath, when, on behalf of Miss M. Talbot, a granddaughter of the late W. H. Fox Talbot and the present owner of Lacock Abbey, a large and historical collection of photographic apparatus was formally handed to Dr. G. H. Rodman, president of the Royal Photographic Society, for preservation in the society's museum at 35 Russell Square, W.C. It was Miss Talbot's desire that the collection should be placed in the care of the Royal Photographic Society, where it will be fittingly conserved with the important Hurter and Driffield collection and other photographic apparatus of national interest. The debt which modern photography owes to Fox Talbot, the brilliant scientific investigator, is not acknowledged so universally as it deserves, and although the credit for the discovery of photography may justly be attributed to the French pioneers, Niepce and Daguerre, Fox Talbot's discovery a short time afterwards revolutionised their process and made photography as it is practised to-day possible. The French process was completely different, and practically died out when wet plates were introduced. Fox Talbot was the first to produce positives from negatives, and as the inventor of the "Calotype" process he earned a title to undying fame. The collection of historical photographic apparatus which has now been entrusted to the care of the Royal Photographic Society includes a camera lucida, a sketching camera, and other scientific instruments which Fox Talbot used in his experiments, and will be specially shown during the approaching annual exhibition of the society, which will be opened to the public on September 19 next.

SOME urgent appeals on behalf of Russian men of science have been received recently in Finland, and the University of Helsingfors has appointed a committee, which is endeavouring to give much-needed assistance. The frontier between Finland and Russia having been partially reopened, some Finns have been able to visit Petrograd and verify the accounts received. Already several wagon-loads of foodstuffs have been dispatched for distribution in Petrograd among men of science and their families, but it is feared that the present grave food shortage in Russian towns will become more acute in the immediate future. Supplies will therefore be required for some months, and the committee fears that the resources of Finland may not be equal to the task. In consequence, an appeal for help in this work is made to men of science throughout the world, and the committee has offered to act as an intermediary in conveying supplies to their destination. Gifts of food, clothing, and books are urgently needed, and the committee at Helsingfors guarantees that all packages entrusted to its care, which should be addressed to Prof. Mikkola, University of Helsingfors, will be delivered to the men for whom they are intended.

A DISPATCH from Col. Howard-Bury, leader of the Mount Everest Expedition, published in the *Times*, describes the course of the party from Kampa Dzong to Tingri Dzong, where they arrived on June 23. The illness of Mr. H. Raeburn, following on the death of Dr. A. M. Kellas, is a blow to the expedition. Mr. Raeburn was sent back to Lachen, in Sikkim, where his speedy recovery is anticipated. The march westward from Kampa Dzong does not appear to have been difficult except at times for transport troubles. The inhabitants were generally helpful. Col. Bury describes the ascent of the easy Tinki Pass leading to the wide valley of the Yaru, a tributary of the Arun. After fording the Yaru some difficulty was experienced in crossing an area of quicksands during a violent sandstorm, but no accident occurred. At Tingri Dzong the expedition was within 50 miles of Mount Everest and on the verge of the real work of exploration.

AT the annual autumn meeting of the Institute of Metals to be held in Birmingham on September 21–23, a number of papers dealing with the constitution and properties of metals and their alloys will be presented. The morning sessions will be devoted to the reading and discussion of papers, and the afternoon sessions will be spent in visits to works and factories of interest in the neighbourhood. The coming meeting will be the first visit paid by the institute to its old home, and the present membership of more than 1300 is significant of the great progress made by the institute since its foundation thirteen years ago, when its membership was 200. A ballot for the election of members desirous of attending the Birmingham meeting is being arranged, and full particulars can be obtained from the Secretary, 36 Victoria Street, London, S.W.1.

WE have received from the National Council of Public Morals (Rhondda House, 60 Gower Street, W.C.1) a pamphlet entitled "To Save the British Race," in which an outline of the activities of the council is given. The Birth-Rate Commission, a Special Committee on Venereal Diseases, an Adolescent Inquiry, and an Education Committee in relation to the kinematograph are some of the inquiries undertaken by the council, and valuable reports have already been published respecting some of these.

AN advisory body, the Scientific Research Committee, has recently been instituted by the Sudan Government for the collection and distribution of scientific information of local interest, which will be published in *Sudan Notes and Records*. In vol. iv., No. 1, of this publication Mr. R. E. Massey has a note on the maintenance of quality of cotton grown in the Sudan, showing that there has been no deterioration over a period of years; while Mr. H. H. King discusses means for the control of the Spanish sparrow, which has become a pest in Dongola Province.

M. V. GALIPPE, who is well known for his papers on micro-organisms, recently claimed (*Comptes rendus*, vol. clxxi., p. 754, October 18, 1920) that "microzymas et bacilles ovoïdes," endowed with movement, could be found in powdered fossils, even after treatment of the fragment used with a Bunsen flame and sterilised liquid reagents. No movement, however, was observed in ferruginous fossils. In co-operation with Mme. G. Souffland, M. Galippe now finds (*Comptes rendus*, vol. clxxii., p. 1252, May 17, 1921) that the same results may be obtained from meteorites and from a variety of igneous rocks, including those erupted by Mont Pelé. The authors are, of course, aware of the difficulties imported into their observations by the phenomenon of Brownian movement; but they state that their ovoid organisms move, while mineral particles of finer grain remain at rest. They believe that organic tissue and water are lost during fossilisation of the organisms, but that these are recovered during the experiments. The processes adopted will seem to most workers distinctly adverse to resurrection. The authors conclude that, if all living things were swept away from the surface of the earth, life would revive, thanks to the existence of the organisms entombed in every kind of rock. It is to be feared that few workers with the microscope will trouble to repeat these experiments, remembering Dr. Hann's observations on the structure of meteorites, and Mr. R. Kirkpatrick's more recent essay on "The Nummulosphere" (NATURE, vol. xci., p. 92, 1913); yet it is possible that the work of M. Galippe may lead to further study of Brownian movement among mineral particles.

THE results of investigations on the froghopper-blight of sugar-cane in Trinidad are given in a memoir of the Department of Agriculture of Trinidad and Tobago by Mr. C. B. Williams. The causative insect, *Tomaspis saccharina*, its life-history, and the nature of the damage done are described, and a section is devoted to the relation of the froghopper to its natural enemies. The sugar-cane is the second important agricultural crop in the island, and during 1917–18 it suffered a loss owing to blight of 300,000*l*. The causes accounting for the heavy outbreak of blight are due to a complicated interworking of many factors. The introduction of the mongoose to the island would not appear to be an important contributory cause. The preliminary conclusions arrived at open up a wide field of fundamental research on the relation between the outbreak of blight and rainfall, the geological contour of certain districts, soil conditions, temperature, rainfall, drainage, manurial treatment, tillage methods, and the relative resistance of varieties of sugar-canes. Direct control is also discussed. The author is to be congratulated on the way in which the results of his investigations are presented. It is highly desirable that sections of the report should be extended by further experimental research.

MEMOIR 122 of the Canadian Geological Survey has recently reached us, and it contains a comprehensive account of the Sheep River gas- and oil-field of Alberta, situated about 50 miles south of Calgary. Prior to 1915 a great deal of development work had already been carried out by several companies, but owing to a variety of circumstances, largely influenced by the war, operations practically ceased in that year, though production has since been maintained intermittently by a few companies. The geology of the area is essentially Cretaceous, and the structures are typical of the eastern foothill ranges of the Rocky Mountains, consisting of sharp folds broken by powerful faulting consequent on long-continued earth stress. The main tectonic feature is that of the Turner Valley anticline, from which the bulk of the oil and gas has been obtained; this involves the Kootenay-Dakota, Benton, and Belly River series (in ascending order); petroliferous horizons are principally confined to the older rocks, four distinct oil-sands being recognised. Water-bearing beds were not penetrated by any of the wells put down, although two of these reached a depth of 3900 ft. The yield of gas is as much as 5,000,000 cub. ft. per day in some cases, while the best oil well (South Alberta Oil Co., No. 1) produces 30 barrels per day. The gas has an average composition of 70 per cent. of methane, the rest being ethane and nitrogen; the oil has a specific gravity of 0·736 (example from the second oil-sand), and is described as a high-grade oil; the yield of petrol, however, varies considerably. As a technical publication this memoir maintains the high standard of excellence characteristic of Canadian official literature.

METEOROLOGICAL results for 1920 at the Falmouth Observatory, a station which is financially assisted by the Meteorological Office, show that bright sunshine was registered for 1508 hours, or 245 hours fewer than the average for the past forty years. A deficiency of sunshine occurred in each month except December. Bright sunshine was registered on 308 days, a figure which is four days above the mean. The mean temperature for the year was 51·4° F., or 0·7° above the average. The absolute maximum for the year was 70·1° F. in August, which is the lowest annual maximum since observations were started fifty years ago. Rainfall was 2·08 in. above the average for the last fifty years. The relative distribution of the wind was in good agreement with the normal. A fifty years' average, 1871–1920, is given for atmospheric pressure, air temperature, rainfall, humidity, and direction of wind for each month and for the year; these add much to the valuable work which is being done at the station.

IN the July issue of the *Philosophical Magazine* Mr. E. C. Kemble, of Harvard University, reviews the evidence now available for testing the various suggestions which have been made as to the constitution of the helium atom. Bohr's hypothesis that it contains two electrons revolving in a common circular orbit is not in keeping with the known value of the ionisation potential. The models of Landé and of Franck and Reiche involve an outer and an inner electron each with its own orbit. Such an outer electron would, on the theories of Langmuir and of Sir Joseph Thomson, determine the chemical behaviour of the atom, and it would be difficult to reconcile the chemical properties of helium with those of the alkali metals. These models also give wrong values for the ionisation potential, and do not harmonise with the spectroscopic observations of Fricke and Lyman. In all the models the average angular momentum of an electron is taken to be an integral multiple of the unit, and, according to Bohr's principle, an electron on changing its orbit emits one or more units of radiation. Mr. Kemble shows that the principle cannot be applied in all cases without leading to inconsistencies, and comes to the conclusion that it must be abandoned.

IN *Science* for May 20 Dr. S. J. Barnett, of the Terrestrial Magnetism Department of the Carnegie Institution, Washington, reviews recent progress in the theory of magnetism and its simplest applications. He shows how the Weber-Langevin theory, according to which the magnetic element contains a permanent whirl of electricity with a definite magnetic moment, is incapable of explaining the known facts of dia-, para-, and ferro-magnetism, and that the magnetic element, or magneton, must be taken as having an angular velocity of its own about some axis which may or may not be an axis of figure. In these circumstances the magneton will behave as a gyrostat, and a rotation impressed on the body of which the magneton forms part will tend to make the magneton set its axis more in the direction of that of rotation of the body, and thus impart to it a magnetisation along the axis of rotation. The gyrostatic magneton in the hands of Ganz and of Honda and Okuba has yielded results which follow very closely the experimental facts, the theory of Ganz covering a wide range of cases, and in particular reproducing accurately the behaviour of dense paramagnetic bodies at low temperatures.

SIR WILLIAM ABNEY'S career as a scientific photographer forms the subject of a memorial lecture delivered by Mr. Chapman Jones before the Royal Photographic Society, and published in the *Photographic Journal* for July. From his youth Sir William Abney had more than a liking for scientific subjects, but photography was his first choice. At that time the spectroscope was beginning to take its proper place as an instrument of investigation, and he was one of the first to enter this new field and to apply the spectroscope to the elucidation of photographic problems. He took advantage of the fact that the exposure effect in a chromated gelatine film, if merely started by light, will continue to grow, and showed how the bugbear of the carbon printers could be turned to useful account. In 1871, if not earlier, Abney devoted his attention to the preparation of photographic emulsions and sensitive films, and later on obtained results from which the modern P.O.P. originated. During about twenty-four years he investigated the nature of the developable image and the course of development. By 1880 he had worked out various methods for printing by development. He made a series of experiments on developing agents, and introduced the use of hydroquinone and the ferrous-citro-oxalate developer, which need no restrainer. One of Abney's most important discoveries he called "the failure of a photographic law." He proved that the time of exposure did not vary exactly inversely to the intensity of light. It was not until 1893, after the subject had been considered for twenty-two years, that he gave details of his investigation of it. He made many successful experiments on photography in natural colours, but his greatest self-contained achievement was his photography of the infra-red. The normal spectrum as photographed on his plates was more than five times the length of the visible spectrum, for they were sensitive to the ultra-violet right away through the visible spectrum to a wave-length of 2200$\mu\mu$. Abney was accustomed to quantitative work from the first, and perhaps the most important service he rendered was the introduction of methods of measurement into scientific photography.

THE *Comptes rendus* of the Paris Academy of Sciences for June 20 contains a note by M. Baille-Barrelle on the production of coke from Sarre coal. By the usual method of coking, this coal is well known to give a poor coke, but M. Baille-Barrelle shows that, by a special mode of heating, Sarre coal can be made to yield a coke comparable with the finest cokes from Ruhr coal. The experiments were made on a semi-industrial scale (charge of 500 kg.), and preliminary work on the extension to a full commercial scale has been commenced. The coal is first maintained at a temperature of 320° C. for some time; then the temperature is slowly raised uniformly to a final temperature of 750° C., or about 200° C. below the usual coking temperature. Figures for the resistance to crushing and shaking are given. It is also claimed that the by-products obtained are superior to those given by the ordinary coke oven, and an investigation into their nature is in progress. The yield of ammonia was unexpectedly high, about double that obtained when the coal is coked in the ordinary way; owing to the lower temperature a reduced quantity of ammonia was anticipated. It is probable that the actual quantity of ammonia produced was less, and that the increased yield was due to the lessened amount decomposed into nitrogen and hydrogen. If the process is successful on the large scale, the Lorraine iron industry will be freed from the necessity of using Ruhr coke.

THE National Physical Laboratory has issued a pamphlet dealing with "Tests on Volumetric Glassware Used in Dairy Chemistry," single copies of which may be obtained free of charge on application to the Director, Metrology (Glass Testing) Department, National Physical Laboratory, Teddington. The pamphlet contains specifications as to size and construction of butyrometers, test-bottles, and pipettes which can be accepted for test by the Laboratory.

Our Astronomical Column.

AURORÆ AT A HEIGHT OF 500 KM.—The careful auroral observations made in Norway and Sweden have established the remarkable fact that some of the streamers extend to the height of 500 km. above the earth's surface. This presumably implies that there is a certain amount of atmosphere at that height, which is a conclusion of cosmical importance.

Geofysiske Publikationer, vol. ii., No. 2, contains an investigation by Dr. Carl Størmer of the height of streamers during the brilliant aurora of March 22–23, 1920. There were seven photographic stations at work in Norway on this occasion, and telephonic communication enabled simultaneous exposures to be made, the cameras being directed to the same stars. The investigation is based on simultaneous photographs taken at Christiania and Kongsberg, which are 65·7 km. apart. The streamers photographed had well-defined edges, and crossed the constellation Cassiopeia, the brighter stars being visible on the plates. The heights of seven points in the streamers are determined as 597, 550, 607, 562, 528, 485, and 519 km. respectively. Two pairs of plates are reproduced, on which the streamers and the stars are clearly visible. The author notes that it is only the extremities of the long rays that attain these great heights. The bases may be as low as 85 to 90 km.

THE MINOR PLANET EROS.—This planet will make one of its near approaches to the earth early in 1931, when there will doubtless be another solar parallax campaign. A parallax still more accurate, however, than that obtained by direct measures will probably be determined by the very large perturbations produced by the earth on the planet's motion. For this purpose it is desirable to obtain accurate observations at every opposition. The planet will next be in opposition in mid-September in N. decl. 14°, magnitude about 10½. Mr. F. E. Seagrave has computed an ephemeris for Greenwich midnight, a portion of which is given below. Corrections, due to G. Stracke, of −22s. and −2′ 7″ have been applied to the right ascension and declination:—

	R.A. h. m. s.	N. Decl. ° ′	Log r	Log Δ
July 23	23 41 24	6 58·1	0·23754	9·98409
27	23 41 23	7 50·6	0·23600	9·96672
31	23 40 42	8 41·8	0·23438	9·94938
Aug. 4	23 39 17	9 31·1	0·23266	9·93211
8	23 37 6	10 18·1	0·23088	9·91512
12	23 34 8	11 2·1	0·22900	9·89861
16	23 30 22	11 43·0	0·22700	9·88265
20	23 25 49	12 19·8	0·22494	9·86759

JUPITER'S FOUR GREAT SATELLITES.—The Annals of Leyden Observatory (vol. xii., parts 1 and 2) consist of researches on these satellites by Prof. W. de Sitter and Dr. A. J. Leckie respectively. These parts were published in 1918 and 1919; they are therefore quite independent of Prof. Sampson's theory, which only appeared in print in 1921. One point of Prof. de Sitter's method is the use of a new intermediary orbit; instead of using the Keplerian ellipse, he substitutes for the eccentricity the great periodic inequalities. This is analogous to the use by Drs. Hill and Brown of the variation oval as intermediary orbit in the lunar theory instead of the Keplerian ellipse.

Prof. de Sitter finds for the masses of the satellites in terms of that of Jupiter 3796, 2541, 8201, and 4523 (units of the 8th decimal). In terms of the moon's mass these are 0·985, 0·659, 2·128, and 1·173. Using the diameters of the satellites found by the interferometer (mean of Hamy's and Michelson's results), viz. 1·00″, 0·905″, 1·325″, and 1·31″ at distance 5 units, the densities become 0·853, 0·788, 0·811, and 0·462 in terms of that of the moon.

Prof. de Sitter's final values of the mean daily motions of I., II., and III. referred to First Point of Aries are 203·48899280°, 101·37476180°, and 50·31764630°. These have been adjusted to fit the relation $n_1 - 3n_2 + 2n_3 = 0$.

Quality of Protein in Nutrition.[1]

By DR. R. H. A. PLIMMER.

THE normal diet of man and animals contains certain nutritional elements every one of which is essential for the maintenance of life and health. These elements are:

(1) Proteins, complex nitrogenous substances found in meat, milk, eggs, cereals, and plant tissues.

(2) Carbohydrates, such as starch in cereals, sugars in fruits, milk, etc.

(3) Fats, such as butter, lard, suet, and vegetable oils.

(4) Salts, or the mineral constituents in meat, milk, cereals, vegetables, etc.

(5) Vitamin A, contained in butter, cod-liver oil, eggs, green vegetables, etc.

(6) Vitamin B, contained in yeast, germ of cereals, meat, eggs, etc.

(7) Vitamin C, contained in some fruits and some vegetables.

(8) Water.

If we examine these food elements in fuller detail we find that in whatever form the carbohydrate is taken in the food it is converted during digestion in the body into a simple sugar, such as grape-sugar; so that for nutritional purposes all carbohydrates can be considered the same. They are burnt up like coal to supply the body with heat and energy.

Fat of almost every source consists mainly of three triglycerides, palmitin, olein, and stearin. The consistency of fats depends simply on the relative proportions of these substances. Certain fats are the vehicles of the A vitamin, but, leaving the vitamin out of consideration, fats are of equal value in nutrition, and, like carbohydrates, they supply fuel for heat and energy. Fats can be built up in the body from the carbohydrate in the food. Some very recent feeding experiments by Osborne and Mendel indicate that fat, as such, can be omitted from the diet if the vitamin A is supplied in a specially prepared form. The special value of fat in nutrition thus depends on the A vitamin associated with it, and not on its chemical constitution.

The mineral salts in an ordinary mixed diet do not need to be supplemented, but generally some sodium chloride is added. Animals on cereal diets must be supplied with this common salt.

Whatever is the source of the three vitamins, so far as we know the A vitamin is the same whether it be in butter or cod-liver oil, B vitamin is the same in yeast and cereal germ, and C vitamin the same in orange-juice or cabbage.

Thus, since each of these elements of the diet is reduced to a simple common basis during digestion, we cannot speak of quality of carbohydrate, fat, or vitamins.

The protein constituent differs from all the others by its endless variety. This is obvious to the naked eye. For instance, the protein in white of egg is in solution, and sets to a hard mass on boiling. Meat protein is already in a solid form. Milk contains two kinds of protein, the casein which is used to make cheese and an albumin like egg-albumin in the whey. The presence of protein in cereals is scarcely recognised, as it is obscured by the large amount of starch, yet about one-tenth of flour is protein; in fact, two very special proteins are present, the one soluble in alcohol, the other insoluble but soluble in dilute alkali.

[1] From a discourse delivered at the Royal Institution on Friday, April 8.

Our usual classification of proteins already indicates their differences, but the variety is really far greater. We need only refer to their chemical analysis. Fischer, Kossel, and their pupils have shown that proteins on hydrolysis break down into some eighteen or twenty amino-acids. These numerous units can be arranged for convenience into eight groups:

(1) *Simple Mono-amino-Acids*: Glycine, alanine, valine, leucine, and *iso*leucine

(2) *Mono-amino-Dibasic Acids*: Aspartic acid and glutamic acid.

(3) *Hydroxyamino-Acids*: Serine and hydroxyglutamic acid.

(4) *Heterocyclic Acids*: Proline and hydroxyproline.

(5) *Mono-amino-Acids with Aromatic Nucleus*: Phenylalanine and tyrosine.

(6) *Mono-amino-Acid with Indole Nucleus*: Tryptophan.

(7) *Hexone Bases or Diamino-Acids*: Lysine, arginine, and histidine.

(8) *Thio-amino-Acid*: Cystine.

The chemical analysis of the proteins shows that the various proteins yield different amounts of the amino-acids. Some of the data are shown in Table I. The peculiarities of each protein are indicated by the figures in heavy type.

TABLE I.

	Ox muscle.	Casein.	Lact-albumin.	Gelatin.	Wheat gliadin.	Wheat glutenin.	Maize zein.	Maize glutenin.	Edestin.	Sturin.
Glycine	2·1	0	0	**19·3**	0	0·9	0	0·3	3·8	
Alanine	3·7	1·5	2·5	3·0	2·0	4·7	9·8		3·6	
Valine	0·8	7·2	0·9		3·4	0·2	1·9		+	
Leucine	11·7	9·4	**19·4**	6·8	6·6	6·0	**19·6**	6·2	**20·9**	
Phenylalanine...	3·2	3·2	2·4	1·0	2·4	2·0	6·6		3·1	
Tyrosine	2·2	4·5	0·9	**0**	1·2	4·3	3·6	3·8	2·1	
Serine		0·5		0·4	0·2	0·7	1·0		0·3	
Cystine				**0**	0·5	0·02			0·3	
Proline	5·8	6·7	4·0	10·4	**13·2**	4·2	9·0	5·0	4·1	
Hydroxyproline		0·3		6·4					2·0	
Aspartic acid ...	4·5	1·4	1·0	1·2	0·6	0·9	1·7	0·7	4·5	
Glutamic acid...	15·5	15·6	10·1	1·8	**43·7**	**23·4**	**26·2**	12·7	18·7	
Tryptophan ...	+	1·5		**0**	1·0	+	**0**	+	+	
Arginine	7·5	3·8	3·2	9·3	3·2	4·7	1·6	7·1	**14·4**	58·2
Lysine	7·6	6·0	**9·2**	5·0	0·2	1·9	0	3·0	1·7	12·0
Histidine... ...	1·8	2·5	2·1	0·4	0·6	1·8	0·8	3·0	2·4	12·9
Ammonia ...	1·1	1·6	1·3	0·4	5·2	4·0	3·6	2·1		
Total ...	67·5	66·5	57·0	65·4	83·0	59·72	85·4	45·7	81·9	83·1

In general, the albumin group of proteins contains all the amino-acids, except glycine, in various proportions. The globulin group is similar, but contains glycine, and has, in addition, a higher amount of glutamic acid, especially those globulins of vegetable origin. The phospho-proteins resemble the albumins, with no striking preponderance of any single amino-acid. The gliadin group of cereal proteins is peculiar in its high content of glutamic acid and proline. The members of the sclero-protein group (horn, hair, and gelatin) are heterogeneous, and here we may note that silk-fibroin is composed mainly of three mono-amino-acids, and is the very antithesis of sturin (the protein of fish sperm), which is made up of the three hexone bases with no, or very little, mono-amino-acids. Gelatin lacks cystine, tyrosine, and tryptophan. Hair is richest in cystine. These are simply some of the most obvious differences. Proteins thus differ markedly in quality.

Our analytical data are far from complete; in no case do the totals of the amino-acids add up to 100. The incompleteness is chiefly due to the great difficulty of separating and estimating the individual amino-acids. There may be still some unknown amino-acids in small quantities; *e.g.* hydroxyglutamic acid has been discovered recently by Dakin by a new extraction method. This method may yet lead to new results; once again it has proved that every new process in connection with the chemistry of the proteins has given a valuable result.

Rather too great stress has been laid upon the analytical figures. The methods scarcely give exactness as far as the decimal figure, and it would have been better if the data had been returned to the nearest whole number. Many workers still give their data to two places of decimals, so that an entirely wrong impression is given of the accuracy of the method. Fischer pointed out that his method was not quantitative, but others have neglected this important statement.

The figures for the hexone bases are more accurate, but it is still not sufficient to express results to two decimal places. Kossel considers that the hexone bases form a special nucleus on account of their presence in all proteins. We might value a protein by its content of hexone bases, but it is not sufficient, because their total only tells us about a third or less of the whole molecule.

Tryptophan, discovered by Hopkins and Cole, is perhaps the most important unit in the protein molecule. It is not estimated except by direct isolation—a method which is laborious and requires considerable skill. Its amount is not known except in casein and a few other proteins. By its distinctive colour reaction with glyoxylic and sulphuric acids it can readily be proved to be a constituent of most proteins.

The amount of cystine in proteins is known only in a few cases, but its amount can be gauged by the sulphur content of the protein. It is the one unit known which contains sulphur, but there are indications that there is another sulphur-containing unit.

The differences in proteins are not confined to such quantitative data; they are still more involved. Fischer's synthetical work with the amino-acids has proved that the amino-acids are combined together in a polypeptide form, *i.e.* the amino-group of one amino-acid is combined with the carboxyl group of another, the amino-group of this acid being united with the carboxyl group of still another. We therefore consider a protein molecule to be a chain of amino-acids, thus:—

$$H_2N{\cdot}CH_2{\cdot}CO{-}NH{\cdot}CH(CH_3){\cdot}CO{-}$$
$$NH{\cdot}CH(C_4H_7){\cdot}CO{-}NH{\cdot}CH(C_3H_5){\cdot}CO{-}$$

This method of combination allows theoretically of endless variation. If we take three amino-acids we can arrange them in six different ways: Glycylalanyltyrosine, glycyltyrosylalanine, alanylglycyltyrosine, alanyltyrosylglycine, tyrosylglycylalanine, and tyrosylalanylglycine. With eighteen or twenty amino-acids the number of arrangements is almost infinite.

Differences in arrangement may be the cause of differences in proteins. Two proteins may perhaps have exactly similar amounts of amino-acids and yet be different; a difference could be expressed by the interchange of one amino-acid. We may imagine the proteins of the blood or milk of different species to differ thus: one may have the arrangement *a, b, c, d, e, f,* the other *d, a, b, f, e, c.*

Another important difference may exist in the so-called tautomerism of the amino-acids and polypeptides. With the same arrangement of the amino-acids we may have several formulæ representing the polypeptide structure. Certain of the properties of the polypeptides can be explained on this basis.

Fischer and Kossel have revolutionised our conception of protein nutrition. We no longer think, like Liebig and others, that the protein of the food becomes directly the protein of the body, for it has been demonstrated by the physiologists that the protein of the food undergoes hydrolysis during digestion to amino-acids, that the amino-acids circulate in the blood, and that the tissues receive amino-acids from which they build up their protein. Proteins must be regarded as a mixture of amino-acids.

We can look upon a protein as we look upon the contents of a box of assorted biscuits, arranged in rows and layers of various kinds. Each biscuit should be connected to its neighbour so that we have a continuous chain. The general appearance of the contents of two boxes is different; in one case we may find sugary biscuits on the top, in another plain ones. In the process of digestion the protein is acted upon by acid in the stomach with the formation of metaprotein. No great chemical change occurs, but we can imagine that the change consists in a tautomeric re-arrangement in preparation for the action of pepsin. Pepsin hydrolyses the protein at certain junctions, forming proteoses and peptones. Their formation can be compared with the separation of the layers of the biscuits. Pancreatic and the further digestion which follow in the intestine separate the individual amino-acids or biscuits entirely. The separate parts circulate to the tissues; the tissues select the ones they require, and form another arrangement of the units or simply replace those which have been used in their metabolism. Digestion and metabolism are a sort of re-shuffling of the units. In the absence of any particular unit the tissue can no longer rebuild its substance, and consequently suffers. The old example of the inadequacy of gelatin is now explained; the tissues require tryptophan, tyrosine, and cystine, and gelatin cannot provide them.

In nutrition there are essentially two problems to study: the formation of new tissue, as in the growth of young animals, and the maintenance of tissue, which undergoes so-called wear-and-tear, in adult animals. In the latter case we have ultimately to ascertain if every unit of the molecule breaks down or certain selected units only. If these are in the middle of a chain it would follow that the whole molecule would undergo metabolism, and not units at the ends alone. The problem resolves itself into ascertaining the function of each amino-acid.

Since the practical difficulties of feeding animals with a mixture of pure amino-acids are far too great, advantage may be taken of feeding incomplete proteins and adding to them the missing unit or units.

Wilcock and Hopkins made the first experiment of this kind in 1906. They selected zein as protein and fed it to mice, in one set alone and in another set with the addition of 2 per cent. of its amount of tryptophan. Young mice on zein alone immediately began to lose weight and generally died in sixteen days; decline in weight also occurred in the other set, but with the added tryptophan death did not occur until the thirtieth day. Adult mice lived twenty-seven days without tryptophan, and forty-nine days with tryptophan. Tryptophan had thus an appreciable effect on the survival period of the animals. Zein is incomplete in respect of other units, and death was probably on this account.

The experiment was repeated in 1916 by Ackroyd and Hopkins under different, but better, conditions.

The animals were first given a mixture of amino-acids from casein (*i.e.* without tryptophan, which is destroyed in hydrolysis by acid) to which tryptophan was added; on the twelfth day the tryptophan was omitted, and included once more on the thirty-fifth day. There was growth during the first period, decline in weight during the second period, followed by growth on inclusion once more of the tryptophan. This is shown by the continuous lines in Fig. 1. The upper dotted line shows continuous growth on complete mixture. The lower dotted line shows loss of weight in absence of tryptophan.

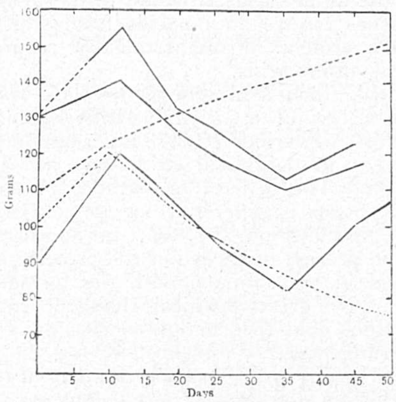


FIG. 1.—After Ackroyd and Hopkins.

Similar experiments have been made by Osborne and Mendel in America. They used the gliadin of wheat as protein. This protein is a complete one, but it contains very little of certain amino-acids, especially lysine. Adult rats were maintained for quite long periods, so long as 500 days, but young rats capable of growth, though maintained for long periods, failed to grow.

We may here notice that though the growth of the animal may be suppressed and it reaches maturity in age, the capacity to grow is not lost. Osborne and Mendel illustrated this by a photograph of a rat which had failed to grow for 273 days, but resumed growth on being given a suitable diet.

The small amount of lysine in gliadin led the authors to regard this unit as essential for growth. In a later experiment they added lysine at intervals; growth took place with the lysine, but not without it. Fig. 2, shows the upward curve of growth with lysine, but no growth without it, in four sets of rats.

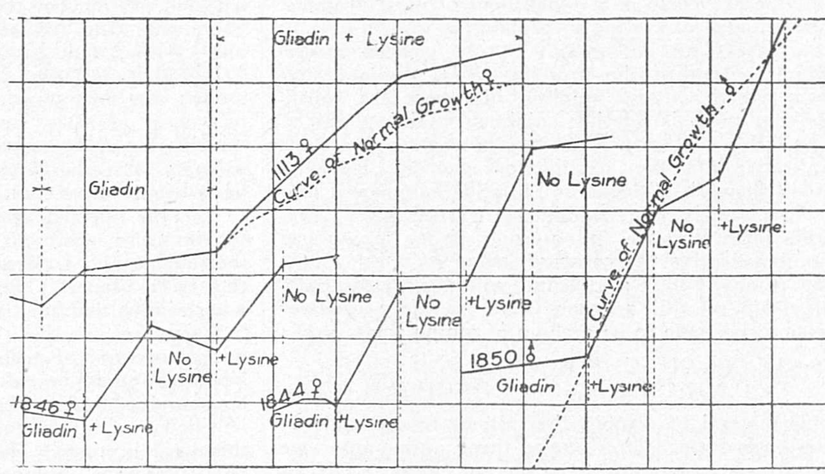


FIG. 2.—After Osborne and Mendel.

The effect of lysine on growth was again demonstrated by Buckner, Nollau, and Kastle in the case of chickens living under the natural conditions of a poultry farm. The birds were fed upon grain mixtures of high and low lysine content; growth was more rapid on the mixture of high lysine content.

The element sulphur is present in proteins in the form of cystine, though it is possible that another sulphur-containing unit is present. Little or no cystine in a protein has also an effect upon the growth of rats. This has been most clearly demonstrated in the case of the protein, phaseolin, of the navy bean. There was slow growth with this protein alone, but normal growth if the protein were supplemented with 2 per cent. of its amount of cystine.

Casein is deficient in cystine. Less casein is required in a diet for producing normal growth; if extra cystine be included 15 per cent. of casein was required by itself, but only 9 per cent. if cystine were added.

The amino-acids containing aromatic nuclei are probably essential units of the protein, but it is difficult to carry out a decisive experiment, since all proteins contain phenylalanine, though they may lack tyrosine. There is plenty of evidence that phenylalanine can be transformed in the body by oxidation; both tyrosine and phenylalanine yield homogentisic acid in cases of alkaptonuria. Totani has shown that the almost complete removal of tyrosine from the mixture of units yielded by casein made no difference to the growth of rats. There was evidently enough phenylalanine for all purposes.

The two hexone bases, arginine and histidine, as shown by Ackroyd and Hopkins, are interrelated in nutrition. Absence of both causes loss of weight; absence of either alone lessens the rate of growth. These two workers further showed that these amino-acids are connected with the production of the purine ring in the animal body, *i.e.* with the production of uric acid.

The function of the whole group of mono-amino-acids has yet to be determined. Are they all necessary? Of glycine we can say that it is not essential, for it is the only amino-acid which the animal can synthesise.

These results remind us of the well-known experiments on the need by plants of all the inorganic elements. Sir Daniel Hall in his "Fertilisers and Manures" gave a striking picture of barley-grains grown on a full food and on foods lacking one constituent. We may thus correlate the amino-acid content of proteins for the growth of animals with the set of inorganic elements needed for the growth of plants.

The relative value of various proteins in nutrition has been studied by Osborne and Mendel. In their experience lactalbumin is superior to casein, and casein to edestin. They found that 50 per cent. more casein and 90 per cent. more edestin were required to produce the same gain in weight; in other terms, a food containing 8 per cent. of lactalbumin was equal to one with 12 per cent. of casein and 15 per cent. of edestin. Fig. 3 shows that the same amount of growth resulted in the same time with these quantities of proteins.

Suitable mixtures of proteins have also been tested, and attempts are being made to find out the most convenient addenda for making the proteins of cereals more adequate for the growth of animals, *i.e.* adding what we may call "good" protein to "bad" protein to make the latter efficient as food. Leaf and seed proteins are good as a mixture. Fig. 4 shows that if zein $\frac{1}{4}$ be supplemented with lactalbumin $\frac{3}{4}$, normal growth results.

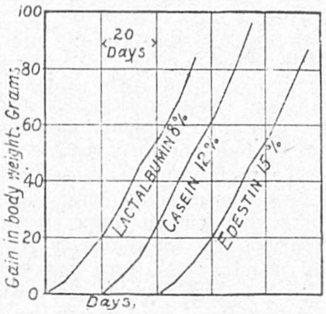


FIG. 3.—After Osborne and Mendel.

Economically, it may be better to use an expensive protein as food for animals and produce rapid growth than to feed for longer periods on poor proteins and get slower growth. A simple calculation brings out the problem to be solved. We may wish to build up the casein of milk with 16 per cent. of glutamic acid, and we are provided with wheat gliadin with more than 40 per cent. of this unit. There is waste of glutamic acid. Gliadin further contains 0·2 per cent. of lysine, whilst casein contains 6 per cent. To produce this

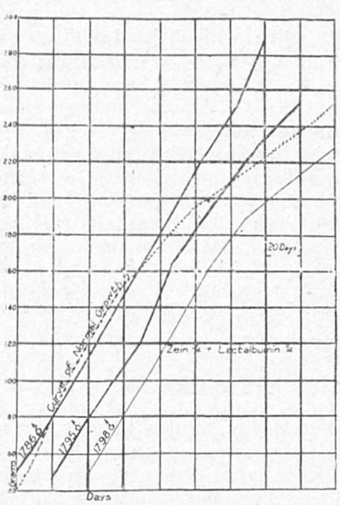


FIG. 4.—After Osborne and Mendel.

amount we require thirty times as much gliadin, and, consequently, the waste of glutamic acid is further increased.

Cannibalism is the most economical method of protein nutrition, as the amino-acids of the food are in the exact proportion required by the tissues. The nearest parallel to this is the nursing of the young animal by its mother; the child actually gets the proteins of the mammary glands.

Recent work shows that quality of protein is most probably the primary cause of the disease pellagra, although there are some indications that general insufficiency of protein together with improper salt supply are contributory factors.

Pellagra is a peculiar disease characterised by severe disturbance of the whole digestive tract, by skin lesions, usually bilaterally symmetrical, and often mistaken at first for sunburn or chapping of the hands, face, neck, and other exposed areas. The nervous system is also affected. There is no definite record of pellagra in Europe before maize was introduced into Spain by Columbus. From Spain the disease spread to France, Lombardy, and eastwards, wherever maize was extensively used for food in the poorer agricultural districts. The relation of maize to the disease puzzled the medical profession for nearly two hundred years, for the disease also occurred where maize was not used, while in some districts maize was used but there was no pellagra. Roussel in 1866 showed that it could be cured by good food, and Lorentz (1914) and Willets (1915) successfully treated advanced cases with a generous diet. Goldberger also cured and prevented the seasonal appearance of pellagra in lunatic asylums and orphanages by increasing the quantity of meat and milk; previously the diet had been deficient in these respects. Goldberger, by the offer of a free pardon from the Governor of Mississippi, was enabled to obtain eleven convicts as volunteers for a feeding experiment to determine if pellagra could be produced by an unbalanced diet in healthy white men. The "pellagra squad," as they were called, were fed on white wheat flour, various maize preparations, polished rice, sugar, sweet potatoes, pork fat, cabbage, and turnip-tops. The food had an energy value of 2950 Calories, and was amply sufficient in this respect, but after the second month on this diet the men complained of weakness, headache, abdominal pain, and other minor discomforts. After five months six of them developed a rash which was pronounced by experts to be identical with that seen in pellagra, and during the last four weeks all the prisoners had shown marked loss of weight and were much out of health. Pellagra would probably have developed in the remainder, but the experiment had to be abandoned owing to the refusal of the men to continue. A control was carried out at the same time; their diet contained some meat, eggs, and buttermilk; there was not a single case of pellagra and no progressive loss of body-weight.

These and other facts clearly point to the diet as the controlling factor in the cause and prevention of the disease. The determining factor seems to be the quality of the protein. Good evidence on this point has been furnished by Wilson, of Cairo. In 1916 pellagra broke out in a camp for Armenian refugees at Port Said. Wilson showed that the diet at first supplied was inadequate both in energy supply (2200 Calories) and in protein supply; indeed, 92 per cent. of the protein was of vegetable origin—three-quarters from wheat and one-quarter from maize.

By determining the least daily amount of a protein required to keep a man from loss of body protein, Thomas was able to assign a series of values to proteins representing their biological efficiency. The *comparative* values according to the quantity required to maintain a man without loss of nitrogen and body-weight were:

Ox-meat ...	104	Rice	88
Cows' milk ...	100	Potato	79
Fish	95	Peas	56
Casein	70	Wheat-flour ...	40
		Maize-meal ...	30

The biological value of meat is therefore three times that of maize. Wilson calculated that the diet as given to the refugees was equal to 22 gm. of casein. On improvement to a casein equivalent of 41 gm. no more cases of pellagra occurred.

Chick and Hume (1920) succeeded in producing in three monkeys symptoms very like those of human pellagra. The diet was very carefully selected, and was deficient only in respect that it contained no animal protein. One monkey refused the food after a short time; he lost weight and showed signs of incipient pellagra. The second monkey also lost weight, but the loss was lessened by adding tryptophan, though the addition of other amino-acids lacking in maize had no appreciable effect. This monkey had signs of pellagra, and was cured by giving a normal diet. The third monkey had its loss of weight arrested by including tryptophan and hexone bases. This monkey showed some of the characteristic symptoms of pellagra, such as the symmetrical bilateral rash.

It appears thus that pellagra is caused by a continuous shortage in the supply of certain amino-acids in the food. A diet containing animal protein in small quantities will supply the needful amino-acids, but a large supply of vegetable protein may not be equally efficient.

The Cawthron Institute, Nelson, N.Z.

THE building and grounds in which the staff of the Cawthron Institute of Scientific Research has commenced its work were formally opened on Saturday evening, April 2, by his Excellency Lord Jellicoe, Governor-General of the Dominion of New Zealand. The building is a fourteen-roomed house, formerly the residence of the late Mr. John Sharp, and has been fitted up with chemical and biological laboratories, a library, a museum, and offices. The grounds provide room for a considerable amount of investigational work, but an experimental orchard and a site for an arboretum have been secured elsewhere. After being shown over the building by the trustees and staff, Lord and Lady Jellicoe adjourned to the School of Music, where a very enthusiastic gathering of citizens awaited them.

In opening the proceedings the chairman of the Trust, the Lord Bishop of Nelson, gave a short *résumé* of the events which led to the founding of the institute under the will of the late Mr. Thomas Cawthron, and explained the nature of the difficulties which had been met in attempting to carry into effect the provisions of the will. He also stated that the trustees had been fortunate in securing the unique entomological library of Dr. David Sharp, the editor of the *Zoological Record*.

Lord Jellicoe, in declaring the institute open, emphasised the importance of the co-operation of the workers in pure science with those engaged in industry. He had seen sufficient of the Cawthron Institute and its staff to convince him that the work carried out in the institute would be of very great value indeed.

An account of the work of the staff was then given by the director, Prof. T. H. Easterfield, who stated that the staff had been working steadily for about eight months. In the chemical laboratory Mr. Rigg, the soil chemist, had obtained sufficient data for the preparation of a preliminary soil-map of the Waimea district, and this was already being eagerly examined by the farmers and fruit-growers of the district. A careful comparison of the chemical constituents of New Zealand mineral oils from various sources had been made by Mr. McClelland. Dr. R. J. Tillyard, the chief biologist, had paid much attention to the question of the control of plant diseases both by inoculation and by the use of natural enemies of insect pests. He had been successful in establishing *Aphelinus mali*, one of the enemies of the woolly aphis. Several entomological papers by Dr. Tillyard and Mr. Alfred Philpott, the assistant entomologist, were already in the press. The relation of hawthorn hedges to the spread of fire-blight and other plant diseases had also been the subject of close inquiry. Dr. Kathleen Curtis, mycologist to the institute, was working out the life-history of several fungoid diseases under New Zealand conditions, and the work was being followed with great interest by the fruit- and tomato-growers. The rapidity with which the building had been converted into a convenient research institute was very largely due to the energy and effectiveness of the curator, Mr. W. C. Davies, whose arrangement of the museum was admirable.

The director announced that during the week following the official opening the institute would be thrown open for four afternoons and one evening, and that the staff would explain the various activities to the public. More than a thousand visitors took advantage of the opportunity to visit the institute.

Institute of Historical Research in London.

THE opening of the new Institute of Historical Research of the University of London in Malet Street, close to the British Museum, on July 8 is a notable event on which warm congratulations may be tendered to the University and to Prof. Pollard. London University has always led the van in the recognition of research, and the new institute is to be devoted to the extension of knowledge. The inauguration of the building has been happily made the occasion of an Anglo-American Conference of Professors of History. London University, a pioneer in so many directions, created in 1920 the first post in England for the history of medicine. We have already referred to the systematic courses in the history of science that are being developed at University College, and it was in harmony with this London tradition that a sectional meeting of the congress was held on Wednesday, July 13, to discuss "Anglo-American Co-operation in the Publication of Documents and Results of Research on Medieval Science and Thought." The meeting was well attended, and the chair was taken by Mr. A. G. Little, who spoke of the immense amount of important medieval material by English writers still waiting to be edited. He emphasised the need of scholars keeping in touch with one another's work.

Dr. Singer spoke of the educational value of the history of science and of the advantages accruing both to professor and student when to specialised research in a purely scientific field is added a general training as a qualification for a degree. Mr. Charles Johnson, of the Public Record Office, suggested that the editing of a text formed an excellent training for historical research, and suggested that such work, carried out for incorporation in the publication of a more experienced scholar, should qualify for a degree. Prof. Tout, of Manchester, while a keen advocate of degrees by research and of the organisation of such research, warned the meeting of the dangers of over-centralisation swamping the student's individuality and power of initiative. Dr. G. G. Coulton, though agreeing that this would be a calamity, pointed out that in Cambridge the thesis was a successful part of the curriculum, and expressed the opinion that with due care the organisation of research was wholly advantageous.

Mrs. Singer briefly described the method of her Catalogue of the Early Scientific Manuscripts in the British Isles, and the assistance it gave to researchers in the history of science, especially to those living far from great libraries. She mentioned that a group of American professors was anxious to utilise the mathematical section for a complete *catalogue raisonné* of the mathematical texts, but that they had so far failed to raise from their universities the sum necessary for transcriptions from the manuscripts. She suggested that if other American universities cared to join in this work it would facilitate the raising of funds. After further discussion a resolution was proposed by Mrs. Singer, seconded by Prof. Tout, and unanimously carried, expressing the hope that the Institute of Historical Research would establish a bureau of texts needing to be edited and of students anxious to undertake such work.

University and Educational Intelligence.

ABERDEEN.—The summer graduation ceremony of the University was held on July 14 in the Mitchell Hall of Marischal College. Degrees to the number of 4 honorary and 145 ordinary were conferred by his Grace the Duke of Richmond and Gordon, Chancellor of the University. Sir George Carmichael, Chief Secretary to the Government of Bombay, and Prof. W. M. Bayliss received the Doctorate of Laws.

EDINBURGH.—At the graduation ceremonial on July 14 the following degrees were conferred:—*Honorary Doctor of Laws:* Mr. John Alison, Headmaster of George Watson's College; his Grace the Duke of Atholl; the Lady Frances Balfour; Mr. Ernest Barker, Principal of King's College, London; Sir John Cowan, Edinburgh; Sir A. W. Currie, Principal and Vice-Chancellor of McGill University; the Right Hon. Sir G. E. Foster, Minister of Trade and Commerce, Canada; Dr. J. S. Haldane; the Right Hon. Sir R. S. Horne, Chancellor of the Exchequer; the Right Hon. T. B. Morison, Lord Advocate; Sir Nil Ratan Sircar, lately Vice-Chancellor of the University of Calcutta; and the Right Hon. Sir Robert Stout, Chancellor of the University of New Zealand. *Doctor of Science:* F. A. E. Crew—thesis, "Contributions to the Study of Sex-determination in the Anura"; E. S. Edie—thesis, "Biochemical Researches"; R. J. S. M'Dowall—thesis, "A Study of the Pulmonary Circulation"; V. E. Parke—thesis, "Specific Heat of Constant Pressure of Hydrogen, Nitrogen, etc."; B. B. Sarkar (Calcutta)—thesis, "Relation between Thyroid and Bone-marrow"; J. Waterston—thesis, "Contributions to Medical and Economic Entomology"; and D. Clouston—thesis, "The Improvement of Cotton Crop in Central Provinces and Berar, and Documents relating thereto" (*in absentia*). *Doctor of Philosophy in the Faculty of Science:* Dr. H. Briggs (Birmingham)—thesis, "Mine Rescue Apparatus and Certain Problems bearing thereon"; Mabel Carmichael (St. Andrews)—thesis, "Electro-synthesis in the Series of Dibasic Acids"; A. R. Normand—thesis, "The Boiling Points of Solutions in Methyl Alcohol under Reduced Pressure"; H. M. Steven—thesis, "The Biology of the Chermes of Spruce and Larch, and their Relation to Forestry"; and Margaret P. White—thesis, "Characteristic Frequencies in Elements of Low Atomic Weight (J Series)."

GLASGOW.—At a recent meeting of the University Court it was announced that the Bellahouston Trustees of Glasgow had made a grant of 500*l.* to the University for the purchase of apparatus required for the department of physiology.

An ordinance for the establishment of the ordinary, as well as the honours, degree of B.Sc. in pure science, under new regulations, has been approved by his Majesty in Council, and will come into operation at the beginning of next session.

Mr. A. Stevens, interim lecturer in geography during the absence of Dr. Falconer, has been appointed lecturer in place of the latter, who has now resigned office.

Prof. F. O. Bower, president of the Royal Society of Edinburgh, has been appointed by the Court a Governor of the West of Scotland Agricultural College.

The building operations for the erection of the new Institute of Zoology, adjoining the Natural Philosophy Institute, have been begun. The estimated cost of the structure is 110,000*l.*

The School of Pharmacy established by the Royal Technical College has been recognised under the affiliation scheme for the purposes of the ordinance for the degree of B.Sc. in pharmacy.

MANCHESTER.—The following appointments have been made:—Senior lecturer in physics, Dr. E. C. S. Dickson; senior lecturer in engineering, Mr. C. M. Mason; lecturer in engineering, Mr. Eric Jones; lecturer in systematic surgery and assistant to professor of systematic surgery, Mr. W. H. Hey; lecturer in clinical surgery and assistant to professor of clinical surgery, Mr. Charles Roberts; lecturer in pathology, Dr. Arnold Renshaw; lecturer in bacteriology, Mr. J. H. Dible; lecturer in morbid anatomy and histology, Mr. B. J. Ryrie; and lecturer in psychology, Mr. R. H. Thouless.

IT is announced that Mr. R. A. Bartram has given the sum of 10,500*l.* to Sunderland Technical College. Of this sum 4500*l.* goes to the building fund for the erection of a drawing office for naval architecture at the college and 400*l.* for its equipment; the remainder, 5600*l.*, will be used to establish an endowment fund for four scholarships in naval architecture.

IT has been pointed out to us with reference to the statistics given on p. 555 of our issue of June 30 in the article on "University Statistics of the United Kingdom, 1919–20," that the University of Bristol draws a considerable number of students from countries outside the British Empire. The number of such students shown in the official returns is fourteen, including three from foreign countries, but to these may be added the corresponding figures thirty and twelve relating to the Merchant Venturers' Technical College, as these are all members of the Faculty of Engineering of the University.

Calendar of Scientific Pioneers.

July 21, 1575. Francesco Maurolico died.—The first of the mathematicians of the Renaissance to study optics, Maurolico was born at Messina and became Abbot of Sta Maria del Porto, in Sicily. His chief work was one on conic sections.

July 21, 1888. Henry Carvill Lewis died.—Known for his glacial studies in the United States and Great Britain, Lewis held the chair of geology in Haverford College, U.S.A.

July 21, 1901. Henri de Lacaze-Duthiers died.—The founder and editor of the *Archives de Zoologie,* Lacaze-Duthiers was the originator of the Marine Zoological Laboratories at Roscoff and Banyuls-sur-Mer, and was known for his important studies of marine invertebrates.

July 22, 1802. Marie François Xavier Bichat died.—One of the greatest of anatomists and physiologists, Bichat was only thirty years of age when he died. Trained under Desault, he became physician to the Hôtel Dieu, where Napoleon caused a memorial to Desault and Bichat to be placed. Bichat's most important works were his "Recherches Physiologiques sur la vie et la mort" (1800) and "Anatomie Générale" (1801).

July 22, 1826. Giuseppe Piazzi died.—Piazzi was the first director of the Palermo Observatory, where on the first day of the nineteenth century he discovered the first of the minor planets called by him Ceres, in allusion to the titular goddess of Sicily. In 1814 he published an important catalogue of 7646 stars.

July 23, 1773. George Edwards died.—Edwards made valuable contributions to the ornithology of his day, and in 1750 received the Copley medal for his book entitled "A Natural History of Birds."

July 23, 1916. Sir William Ramsay died.—Born at Glasgow on October 2, 1852, and educated at Glasgow and Tübingen, Ramsay from 1881 to 1887 was Principal of University College, Bristol, and then succeeded Williamson as professor of chemistry in University College, London. He did important work in many branches of physical chemistry, and became famous the world over for his researches on argon and other rare gases of the atmosphere, the discovery of terrestrial helium, and his investigation of radium emanation. He was knighted in 1902.

July 25, 1903. Mathieu Prosper Henri died.—Prosper Henri and his brother Paul (1845–1905) were from 1868 onwards assistant astronomers at the Paris Observatory, where they had an important share in the development of the great International Photographic Chart of the Heavens inaugurated by Gill and Mouchez.

July 27, 1759. Pierre Louis Moreau de Maupertuis died.—A native of St. Malo and a member of the Paris Academy of Sciences, Maupertuis, who visited London in 1727, the same year as Voltaire, was the first in France publicly to support the views of Newton. With Clairaut he assisted in the measurement of a degree of meridian in Lapland, and afterwards, on the invitation of Frederick the Great, became president of the Berlin Academy of Sciences.

July 27, 1844. John Dalton died.—Born in Cumberland in 1766, Dalton from boyhood was engaged in teaching, and for the last fifty years of his life was connected with the Manchester Literary and Philosophical Society. His meteorological studies and his investigation of gases and vapours led to his discovery of the law of thermal expansion of gases and to the enunciation of the atomic theory. In 1808 he published his "System of Chemical Philosophy." After the death of Davy he was elected one of the eight foreign associates of the Paris Academy of Sciences.

E. C. S.

Societies and Academies.

LONDON.

Aristotelian Society, July 4.—Prof. G. Dawes Hicks, vice-president, in the chair.—Dr. F. C. S. **Schiller**: Arguing in a circle. A scientific system is essentially *partial*. Being constructed by selections and exclusions and relative to a purpose, it contains no warrant for the postulation of any all-embracing system. Objections to a system cannot be met by arguing within it. To meet a challenge it must obtain outside support. If it is to give satisfaction it must not close itself, but remain open to correction. The sciences are such systems, and so escape the charge of circularity. An all-embracing system is not a valid ideal, because inability to select would reduce it to chaos, while if logically complete it could be rejected as a whole. Also it is self-contradictory, for either it can be enlarged to satisfy objections, and then it is not all-embracing, or it cannot be enlarged, and then it argues in a circle. If it presupposes relativity to purpose, it cannot reach absoluteness. The attempt to base inference on implication within an ideal system is no improvement on formal logic, but merely a half-way house to a complete surrender of the notion of "formal validity."

PARIS.

Academy of Sciences, June 27.—M. Georges Lemoine in the chair.—M. **Riquier**: The complete families of integral figures of a system of partial differential equations of the first order.—J. **Kampé de Fériet**: Systems of partial differential equations of the most general hypergeometrical functions.—M. **Hadamard**: Systems of partial differentials, comprising as many equations as unknown functions.—T. **Varopoulos**: A class of transcendental functions.—M. **d'Ocagne**: Lines of curvature of quadrics.—J. **Andrade**: The problem of starting (a chronometer), and sustained pendular movements.—A. **Thuloup**: The equilibrium and stability of elastic apparatus.—F. **Quénisset**: Photographs of the planet Venus. On February 23, 1921, an observation with the 24-cm. equatorial showed a marked grey spot on the edge of the planet near the centre. Seventeen photographs were immediately taken with varying exposures, and a diagram is shown giving the appearance of the planet as taken from these negatives.—M. **Juvet**: The formulæ of Frenet for a Weyl space.—L. **de Broglie** and A. **Dauvillier**: The electronic structure of the heavy atoms. A comparison of the physico-chemical indications concerning the electronic structure of the elements with those furnished by a study of their X-ray spectra.—G. **Ranque**: A new mercury pump. A circulating mercury pump, requiring only 400 grams of mercury, worked with an auxiliary water pump.—M. **Chevenard**: Relation between the anomalous expansion and thermal variation of magnetisation of ferromagnetic bodies.—R. **Dubrisay**: The action of boric acid on glycerol and the polyvalent alcohols. The application of a new physico-chemical volumetric method.—E. L. **Dupuy**: The influence of welding on the resistivity of iron. The presence of ferric oxide in the metal causes an increase in the electrical resistance.—MM. **Dervin** and **Olmer**: Ammoniacal silver carbonate. This is formed by the action of atmospheric carbon dioxide upon an ammoniacal solution of silver oxide. It forms colourless hexagonal crystals, and has the composition $Ag_2CO_3,4NH_3,H_2O$.—E. **Decarrière**: The *rôle* of the gaseous impurities in the catalytic oxidation of ammonia. Details of a study of the effects of hydrogen sulphide as impurity in the ammonia.—L. **Lutaud**: General remarks on the tectonics of the pre-Riffian zone of northern R'arb, Morocco.—S. **Stefanescu**: The phylogenetic and evolutive value of the lamellar formulæ of the last molars, $M\frac{1}{1}$, $M\frac{2}{2}$, $M\frac{3}{3}$, of mastodons and elephants.—C. **Störmer**: The aurora borealis of May 13, 1920. Simultaneous photographs from pairs of stations formed a basis for calculating the heights of various points of the aurora. The distances from the earth were between 192 and 470 kilometres.—E. **Delcambre** and Ph. **Schereschewsky**: A new method for predicting barometric variations.—A. **Guilliermond**: The microsomes and the lipoid formations of the plant cell. The microsomes appear to be simple products of cell metabolism. They are usually constituted by lipoids, sometimes with neutral fats. Hence the terms microsome and spherome are unsuitable, and should be replaced by lipoid granulations.—E. **Couvreur** and P. **Chosson**: The mode of action of plant rennets.—S. **Tchahotine**: The microscopic radiopuncture of mobile cells.—J. **Lopez-Lomba** and P. **Portier**: The physiological mechanism of the resistance of the rabbit to avitaminosis. Adult rabbits resist indefinitely a diet sterilised at a high temperature; this appears to be due to the bacteria which normally develop in the lymphoid tissue, these providing the vitamins missing from the food.—A. **Dehorne**: The mechanism of somatic metaphase and anaphase, and its consequences in *Corethra plumicornis*.—A. **Weber**: Grafts of the eggs of tritons in the peritoneal cavity of salamanders.—A. **Labbé**: The evolutive cycle of *Dunaliella salina*.—Mlle. Lucienne **Dehorne**: Conditions of the development of the durable egg in Phyllopods.—A. Ch. **Hollande**: The presence of a new Spirochætoid, *Cristispirella caviae*, with well-developed undulating membrane, in the intestine of the guinea-pig.—P. **Courmont**, A. **Rochain**, and F. **Laupin**: The purification from bacteria and the coli bacillus in the course of treatment of sewage by the activated sludge method.

ROME.

Reale Accademia nazionale dei Lincei, April 17.—F. D'Ovidio, president, in the chair.—Papers by fellows:—C. **Segre**: Principal lines of a surface of $S5$ and a characteristic property of Veronese's surfaces, ii. In $S2k+1$, when k is even the infinitesimal order of contiguity of two Sk's is always odd.—F. **Severi**: Theory of simple integrals of first species belonging to an algebraic surface, iii. Every Abelian function of the body "omega" is a holomorphic or meromorphic function of y about every value which is neither singular nor critical.—A. **Abetti**: Applications of vectorial calculus to astronomy. Two formulæ are obtained agreeing with those of Chauvenet for the annual precession in longitude.—A. **Angeli** (fellow) and A. **Pieroni**: A work by Prof. E. Salkowski on melanin.—Papers communicated through a fellow:—O. **Lazzarino**: Limiting motions of a semi-rigid body about a fixed point under no forces. A continuation of previous work on motion of a solid with cavities containing viscous liquid. The ultimate motion is what one would necessarily expect.—M. **Pascal**: Superficial circulation, iii. Expressions for the force of sustentation in the case of a fluid current in space. The expressions for the force components of sustentation represent a generalisation of the ordinary hydrodynamical problem from two- to three-dimensional motions.—E. G. **Togliatti**: Three-dimensional varieties of fourth order which are loci of at least "infinity squared" straight lines, i.—L. **Pieragnoli**: Pathology of Pliocene and post-Pliocene mammals of Tuscany. Specimens in the museum at Florence of *Equus stenonis*, *E. caballus*, Cervus (sp.), *Rhinoceros etruscus*, and *Bison priscus* show various lesions, but without traces of tuberculosis except in one bone of Cervus. The specimens in question mostly came from Valdarno. The author compares these results with the remains from Equi, in which tuberculosis was prevalent in *Ursus spelaeus*, while the lesions of the Florentine remains were there lacking.

May 2.—V. Volterra, vice-president, in the chair.—Papers by fellows:—A. **Angeli**: "Various observations" (action of pyridin on nitric ethers, coagulation of solutions of nitro-cellulose, production of certain sparks, experiments to show explosive properties of certain nitro-derivatives).—C. **De Stefani**: Ligurian fossil sponges, vi.: Internal strata of the western crystalline zone (Costa di Sant' Alberto, Voltri Station, Mele, Campo Ligure).—L. **De Marchi**: Vertical temperature gradient in the atmosphere. A modification of the usual thermodynamic formula in order to meet certain objections.—G. **Fubini**: Projective theory of congruences W.—F. **Severi**: Integrals of first species, iv.—G. **Bruni**: A new process for the cold vulcanisation of rubber. The specification refers to the process of generating the thiocarbanilide or other accelerator by a chemical reaction within the mass of rubber to be vulcanised instead of adding it in its final form. The author also cites an analogous process described in America by Scott and Bedford, who, however, use another accelerator.—In the next paper, communicated by Bruni, E. **Romani** shows that bisulphide of thiouramine is capable of vulcanising rubber even without the addition of free sulphur, a result not recorded by the American writers.—Prof. Volterra announced the death on April 16 of Prof. Gino Galeotti.

LAHORE.

Philosophical Society, October 15, 1920.—Dr. B. Sahni, president, in the chair.—G. S. D. **Ahluwalia**: The prevention and cure of plant diseases.

November 24, 1920.—Dr. B. Sahni, president, in the chair.—C. V. **Raman**: Ripples.

December 13, 1920.—Dr. B. Sahni, president, in the chair.—M. L. **Bhatia**: Some observations on the Lahore centipedes.

March 14, 1921.—Dr. B. Sahni, president, in the chair.—N. A. **Yajnik** and D. R. **Sarma**: Some investigations on indigo textile hydrosulphite vat-dyeing. As a result of careful investigations it was found that indigo can be best reduced by hydrosulphite NF in alkaline medium ranging from 0·1 per cent. to 5 per cent. NaOH in the ratio of 1 : 1·5 by weight. Unfavourable influence of the slight excess of free alkali in the vat can be to a great extent controlled by the addition of acetic acid, boracic acid, etc., and it was found that very small quantities (up to about 1 per cent.) of these gave greater absorption coefficient and better shades. The nature of the action is not yet clearly understood, but the effect of these additions is likely to be of great technical importance.

March 21.—Dr. B. Sahni, president, in the chair.—A. **Chandra**: Chemical constitution and optical activity, with special reference to camphor-amide derivatives.—B. K. **Singh** and M. **Singh**: 1 : 4-Naphthylene bisiminocamphor. This substance possesses the highest rotatory power hitherto observed.—B. **Sahni**: The cuticular structure of *Glossopteris angustifolia*, Brongn. From the form and venation alone it is so difficult to distinguish *G. indica*, Schimp., and *G. angustifolia*, Brongn., that the specific distinctness of the two has been doubted. The structure of the cuticle of *G. indica* was described by Zeiller in 1896; that of *G. angustifolia* now investigated shows well-marked differences which help to establish the two forms as distinct species.

May 19.—Dr. B. Sahni, president, in the chair.—B. I. **Das**: Sidelights on modern science from the ancient sastras.—N. A. **Yajnik** and H. C. **Mahajan**: Hydrolysis of some Indian oils by vegetable lipase. The following oils were tried: (1) Linseed oil, (2) soapnut oil (from the seeds of *Sapindus trifoliatus*), (3) sukh-chain oil (from the seeds of *Pongamia glabra*), (4) neem oil (from the seeds of *Melia azadirachta*), and (5) sesamum oil. Of these sukh-chain oil and soapnut oil were not pressed so far from their seeds, but were specially extracted for the purpose of investigation, and they were found to be of particular interest on account of the extent to which they can easily be hydrolysed.

Books Received.

Air Ministry: Meteorological Office. Professional Notes No. 18. Lizard Balloons for Signalling the Ratio of Pressure to Temperature. By L. F. Richardson. (M.O. 240h.) Pp. 73–93. (London: H.M. Stationery Office.) 1*s*. net.

Memoirs of the Geological Survey: England and Wales. A Short Account of the Geology of the Isle of Wight. By H. J. Osborne White. Pp. v+219. (London: E. Stanford, Ltd.; Southampton: Ordnance Survey Office.) 10*s*. net.

Die Prinzipien der Physikalischen Optik. By Ernst Mach. Pp. x+444. (Leipzig: J. A. Barth.) 48 marks.

An Elementary Handbook of Commercial Geography. By J. W. T. Harris. Pp. 32. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 10*d*.

A Treatise on the Integral Calculus, with Applications, Examples, and Problems. By J. Edwards. Vol. i. Pp. xxi+907. (London: Macmillan and Co., Ltd.) 50*s*. net.

Optical Theories. Based on Lectures delivered before the Calcutta University by Prof. D. N. Mallik. Second edition, revised. Pp. vii+202. (Cambridge: At the University Press.) 16*s*. net.

Bureau of Education, India. Indian Education in 1919–20. Pp. iii+89+18 plates. (Calcutta: Government Printing Office.) 2.2 rupees.

Icones Plantarum Formosanarum. By Bunzō Hayata. Vol. x. Pp. iv+335. (Taihoku: Bureau of Productive Industries.)

New Alt-Azimuth Tables, 65° N. to 65° S. Pp. xvii+154. (Tokyo: Hydrographic Department.)

Mécanismes Communs aux Phénomènes Disparates. By Prof. M. Petrovitch. (Nouvelle Collection scientifique.) Pp. v+279. (Paris: F. Alcan.) 8 francs.

Botanical Memoirs. No. 4: Elementary Notes on Structural Botany. By A. H. Church. Pp. 27. 2*s*. net. No. 5: Elementary Notes on the Reproduction of Angiosperms. By A. H. Church. Pp. 24. 2*s*. net. No. 6: On the Interpretation of Phenomena of Phyllotaxis. By A. H. Church. Pp. 58+xvi plates. 3*s*. 6*d*. net. No. 7: Elementary Notes on the Morphology of Fungi. By A. H. Church. Pp. 29. 2*s*. net. No. 8: Elementary Notes on Conifers. By A. H. Church. Pp. 32. 2*s*. net. No. 9: Form Factors in Coniferæ. By A. H. Church. Pp. 28. 2*s*. net. (London: Oxford University Press.)

Field Mapping for the Oil Geologist. By C. A. Warner. Pp. x+145. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 13*s*. 6*d*. net.

Elements of Engineering Geology. By Prof. H. Ries and Prof. T. L. Watson. Pp. v+365. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 22*s*. net.

Lichens. By A. L. Smith. (Cambridge Botanical Handbooks.) Pp. xxviii+464. (Cambridge: At the University Press.) 55*s*. net.

The Theory of the Induction Coil. By Prof. E. Taylor-Jones. Pp. xi+217. (London: Sir I. Pitman and Sons, Ltd.) 12*s*. 6*d*. net.

A New System of Scientific Procedure: Being an Attempt to Ascertain, Develop, and Systematise the General Methods Employed in Modern Enquiries at their Best. By G. Spiller. Pp. ix+441. (London: Chatto and Windus.) 10*s*. 6*d*. net.

Diary of Societies.

THURSDAY, JULY 21.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION (at Institution of Electrical Engineers), at 10 a.m.—D. Wilson: Steam Raising: Yesterday, To-Day, and To Morrow.—W. H. Miles: Modern Boiler House Practice.—At 2.30.—E. Cross: Present-Day and Commercial Problems in Electricity Supply.

FRIDAY, JULY 22.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION (at Institution of Electrical Engineers), at 10.15 a.m.—Annual General Meeting.

MONDAY, JULY 25.

ROYAL SOCIETY OF MEDICINE, at 5.30.—Dr. M. Diamond: Some New Phases of Old Problems in Dental Reconstruction.

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