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Science and Government Administration.

SENSE, experience, humility, and imagination may teach one the need of advice: but some understanding of the subject is required to know whom to ask for advice and how to ask him; and still more to select advice, apply it, and act on it. In scientific matters this receptiveness of the recipient is an essential condition, otherwise the adviser is merely pouring water upon a flat plate; it bounces off, yet the plate shines and glories in its wetness.

In view of the supremely scientific character of modern war, can we say that the Army Council, Board of Admiralty, and Air Force Council possess the *sine qua non* for asking, selecting, applying, and acting on scientific advice in relation to the myriad problems of their occupation? These administrative bodies are called upon to foresee the wants of war and to make purchases and initiate researches for their fulfilment. They should, therefore, not only know what is wanted, but also understand what can be obtained. In the restricted sense of this use of the word "want" Julius Cæsar did not *want* electric light. He would have had to be even more remarkable than he was to want it, and then he could not have described the want effectively to any listener.

It is quite common for the lay public to be too unacquainted with what it can get to form a clear idea of its requirements—the man who tries to install central heating, or drains, without architect or builder will understand what is here meant. Luckily most people have sufficient knowledge of the subject and feeling of humility to determine them to go to the architect—that is because central heating and drains are everyday things. The lay public did not want railways—it did not know how to want them; it did not want automobiles until some years of education had been applied, and, coming nearer to our subject, the Army and Navy did not want aeroplanes until long after they were shown them. We are not making an accusation, but merely giving examples to show that the human faculty of wanting is a function of knowing what can be evolved, that is, education; and of imagining to what uses that provision can be extended, that is, vision.

There is the reciprocal of this also in "*not*-wanting." Ask any young officer at random if he wants the Finance Member of the Army Council; facetiously, but not without disclosing a true feeling, he will reply that "he has no use for him." With fairly precise analogy, if it were to be suggested to any member of the three councils named that a man of distinguished scientific attainments is wanted on these councils, he would with equal conviction, equal error, and possibly with equal facetiousness say, they "have no use for him" . . . "they have their advisers."

Suppose that there rises to the top at rare intervals a scientific admiral, "M.G.O.," or "Member for Supply and Research," it still remains the fact that in the absence of provision for securing by the law of the land that there *shall* be a man of wide scientific attainments on those councils, we cannot depend that, when a problem arises in council, its possible relation to science will be automatically and early considered. In many cases science will not be thought to touch the matter at all—and no attempt be made to get such advice. Unless there be some one, with full rights of membership, to probe into what can "per impossibile" be got from science, it is no comfort to know that there exist outside the Council advisers of great skill—since they would not be consulted—nay, they could not be consulted owing to the difficulty for the inexpert to pose the question even if he suspects the want.

A strong case can be made out for a scientific member of council—present at the fountain-head of war policy—at the place where the large problems arise, just as there is, at present, a finance member of council. The analogy of the finance member is apt because the public mind is far more financially sensitive and sane than scientifically acute and trained. Indeed, these councils themselves are almost certainly more awake to finance than they are to science. Is there not a House of Commons and a Press with money sense and taxation sensitiveness? But there is no similar power behind the scientific aspects of the case. It is not worth while to pose the false dilemma: which won the war, money or science? But it may be said that it is no use thinking the nation can safeguard its money if it does not safeguard its science. The awareness in money matters of the public due to its daily preoccupations, its annual state accountancy, etc., has ensured for money a representative at headquarters, but science has nothing of the kind.

No doubt the appeal of science would be better appreciated if it were expressed on terms of money. As an illustration of this the following episode is worth relating. The war council of a certain State was in session. A grave question had to be settled: advisers were outside the sacred chamber whence a member of council emerged, and, taking aside a man of science of European reputation who was in attendance and in the employ of that Army, propounded a question. As happens in such cases the inquiry sounded like: "How far is it from Somaliland to Good Friday?" so that the reply (and who has not gone through this ordeal!) began by hypothecating the alternative possible meanings and an inquiry as to which was intended. "I am not here to be interrogated but to be answered," was the reply inspired by a very proper fear of disclosing a clue to the secret policy in contemplation. The representative of science then gave an elementary lecture in which he reserved with dramatic instinct the essence of his reply for the climax. Before that was reached, however, the august member had excused himself and returned to his colleagues—fortified as a schoolboy would be for the reading of Plato by a knowledge of his subject limited to the alphabet. In the sequel some millions (not of marks) were expended on the scheme, which, however, was unfruitful.

Events and actions of this kind can be avoided only if the following principles are borne in mind:

(1) It is difficult even to ask for scientific advice so as to get it—unless the inquirer has scientific training.

(2) After asking for advice it cannot be taken without scientific training.

(3) When advice is taken it cannot be made effective without scientific training.

(4) However scientifically competent a man may be, he cannot advise on a case without knowing *à fond* how the problem arose and when, what qualifies it, and what alternatives might be employed to bye-pass the difficulty while still arriving at the goal.

It must be accepted that a genuine and thorough scientific training is not compatible with the multifarious changes of duty, changes of locality, changes of personnel, etc., essential to naval, military, and air force training. The development of a versatile, more or less uniformly trained force requires a *rota* of occupations by which officers and men, at stated periods of two or three years, are moved on to the various forms or classes which constitute the war school we call the Army, Navy, and Air Force. It is an accepted principle that no fighting man must become an indispensable expert; his loss would be too severe a discomfiture—his *ipse dixit* too formidable a threat to authority—his specialised training, and the unexpected bye-paths into which the laws of Nature would lead him, too incompatible with the whole principle of a versatile force of obedient and capable units united by a sedulously cultivated esprit de corps.

This is sound policy, and its acceptance leads to the conclusion that the scientific member of council cannot, any more than the finance member, be one of the routine organisation as we know it. We need scarcely plead here, after the War, that there is not, in a man of distinguished scientific attainments, any inherent unworthiness to be entrusted with State secrets. There is nothing peculiar about a suitably selected major-general that makes him a more acceptable recipient of such secrets than an equally well-chosen man of science. Nor yet is administrative ability incompatible with the widest range of scientific attainments.

The present-day divorce between the science which must infuse the war machine and the men who administer it is *not* of all time. Of old, as now, transport,

communications, weapons, archery, etc., involved a knowledge of man's endurance, food consumption, horses, shoe leather, the elastic qualities of yew, the flight path of arrows, and the like, but then, unlike to-day, every member of the governing staff was easily an adept in these matters, competent to select and profit by any expert specialisation—when for a spell generals commanded the fleet they were soon discovered not to be adept and the sea was entrusted to those who were. In both cases it was unnecessary to provide a seat on the council for the astrologer, alchemist, or magician of the time. To-day, however, all this is changed.

It is not to be expected that even a carefully chosen and widely informed scientific member of council can know ballistics, meteorology, chemistry, metallurgy, the thermodynamics of the petrol engine, the intricacies of sound detection, or of wireless procedures, the stability of ships, the phugoids of aeroplanes, the rotary derivatives of their equations of motion, etc.; but given a really sound scientific representative none of these subjects is to him what most of them are to the Army Council, Admiralty, and Air Force Council—at the best, jargon: at the worst, stupidity. Such a man would and could seek advice, because he knows enough of the problem and of the outlook of science to see that it was wanted. He could take advice because he would know enough to sift it, test it, select it, and present it for consideration to a council with the real purpose and personalities of which he would be acquainted.

How can we make such a need be felt by the war machine, which is certainly not asking our advice about it? Only by public opinion; and clearly this is difficult. Scientific opinion deserves better regard and esteem than it gets, and it suffers this loss because of the quite unreasonable contempt with which it views the operations of politicians. The world of science abstains from making its voice heard in the only way it can be heard, through the megaphone of the politician, by reason of the pressure of its organisation. It has itself no organisation. Some of the wiser men, who lifted their heads from the absorbing interest of their own grindstones, did in fact form a Conjoint Board of Scientific Societies, which died a month ago. This body comprised the leading Institutions and Societies in the British Isles concerned with pure and applied science. It might have leavened the lump, and reminded the technical world that it is an organic part of modern social organisation. Let us hope, as taxpayers, if from no higher motive, that science and technology may yet form a federation to promote recognition of their significance in the affairs of the State.

MERVYN O'GORMAN.

The Structure of the Atom.

The Theory of Spectra and Atomic Constitution: Three Essays. By Prof. Niels Bohr. Pp. x+126. (Cambridge: At the University Press, 1922.) 7*s.* 6*d.* net.

THE beautiful conception which inspires and co-ordinates practically the whole of modern atomic physics is the atomic model of Rutherford and Bohr. Its essential feature—the nucleus—was first put forward by Rutherford in 1911 on the basis of experiments on the scattering of α-particles. So convincing is this model that after only twelve years it is known no longer as "the atomic model of Rutherford and Bohr," but is simply taken for granted as "the atom." In this development, moreover, the ideas of Bohr have played such a dominating part that it is of the greatest importance that the three essays of this volume should be accessible in English, as well as in the original Danish and German, to the widest circle of readers. We welcome most heartily their opportune appearance.

When a theory such as the present is expounded semi-historically by its principal creator, a critical account of the theory itself is scarcely the function of a review. Such a critical discussion could be nothing less than an exhaustive survey of the whole tendencies of modern physics. It is perhaps a less impossible—certainly a more relevant—task to attempt to bring to notice the various stages of the theory represented by the three essays in this book, in the hope that some faint reflections of their beauty and convincingness may be conveyed to those whose studies are directed elsewhere.

Some preliminary remarks of a general nature may not be out of place. Though the theory itself finds a place for much advanced mathematical analysis and demands the development of new and more powerful weapons than those yet available, in the hands of Bohr it is never an abstraction divorced from contact with physical realities. Rather he succeeds in bringing it ever into closer contact, and expounds it in these essays in a simple non-mathematical way which should be capable of being followed by any one who is prepared to accept the mathematical theorems on which the work is necessarily based. The mathematician will desire to look further into the foundations and will be rewarded. But those who are not mathematicians need not for that reason fall short of full conviction. It is unavoidable to speak of the theory, in description or exposition, as "explaining" certain facts of experience. But the theory is non-mechanical—in fact, is nowadays identical with the quantum theory—and "explanation" by the theory cannot mean explanation in the classical sense. Explanation of a fact can mean no more than its correlation with and co-ordination among an existing

body of other facts which can all be similarly related to the same general principles; this, however, is enough. Beyond this we can ask for nothing less than a reformulation of the whole principles of physics, which shall present both classical mechanics and electromechanics and the quantum theory as parts of a homogeneous whole. So far the divergencies between the two theories have become, if anything, rather more than less fundamental and mysterious, but the points of contact between the two theories, embodied mainly in Bohr's correspondence principle, have become ever more numerous and more sure. They are linked in a way which compels regard for them as two aspects of the same reality. It is the range and power of the correspondence principle, emphasising all these resemblances, which gives the theory its overwhelming appeal.

It is unnecessary to dwell on the first essay—"On the Spectrum of Hydrogen" (December 1913)—which presents, in a way now generally familiar, the suggestive but *ad hoc* arguments by which Bohr started the theory with such a combination of the ideas of Planck and Rutherford as to explain the spectra of the atoms of hydrogen and ionised helium and to promise an interpretation of the general laws of spectra. We pass to the second, "On the Series Spectra of the Elements" (April 1920), which breaks fresher ground. During 1913–1920 the theory had developed rapidly in its applications to subsidiary features of the hydrogen spectrum, which, besides Bohr and others, Sommerfeld, Schwartzschild, Epstein, and Debye took part in working out. It was extended to account with complete success for the fine structure of the hydrogen lines, and the effect thereon of external electric or magnetic fields. These advances can be summarised by saying that the way had been discovered for applying the quantum theory to a certain class of atomic systems of any number of degrees of freedom. This class is technically known as the class of quasi-periodic systems which permit of separation of the variables. Meanwhile Bohr put forward his correspondence principle, of which the germ is already present in the first essay, and the principle of mechanical transformability which he derived from Ehrenfest; principles which knit the foregoing results into a co-ordinated whole.

Briefly, the correspondence principle is this. If we expand the motion of a system in a series of sines and cosines of the time, a multiple Fourier series, in the complete radiation of the system demanded by classical theory a component of definite frequency, a definite "combination tone," will correspond to each term in the expansion. The correspondence principle asserts that there is a fundamental connexion between each "combination tone" and the possible switches from orbit to orbit, or changes of quantum number, which, on the quantum theory, give rise to radiation. In the limiting case of large quantum numbers there must be full agreement not only in frequencies but also in polarisations and intensities. This presents a rational means for extending the correspondence to all quantum numbers; every switch "corresponds" to a definite harmonic constituent in the mechanical motion of the atom. If any particular constituent is absent not only from the motion in the initial and final states but also from the whole family of mechanically possible motions, which are not themselves permitted orbits or stationary states but form a continuous transition between the initial and final states, then the corresponding switch will never occur. The complete success of this principle in accounting for details of the hydrogen spectrum is well known. A successful beginning has even been made by Kramers in the study by its means of relative intensities.

This, however, is only part of the ground covered by the second essay, which also applies these ideas to other spectra, in particular those of helium and the alkali metals. These sections must be read with Parts II. and III. of the third essay, which make important corrections. First, the assumptions of stationary states and the fundamental relation $E=h\nu$ between energy and frequency (first essay) explain naturally the combination principle of Ritz, for Ritz's "terms," the combinations of which are spectral lines, have now a physical meaning as the energies of the atom in its various stationary states. Consider a concrete example —sodium—with nuclear charge 11 and 11 planetary electrons. The inert properties of neon (10) indicate that we must suppose that the first ten electrons form together a very stable structure into which no further electron can be taken up on the same footing.

To a first approximation then, from the point of view of the eleventh electron, the effect of the first ten will simply be to modify the field in which it moves, so that, while its central symmetry is approximately preserved, the effective nuclear charge is a function of the distance from the nucleus, which is 11 at short distances and 1 at large. The same arguments hold for other alkali metals. If the exact law of variation of effective nuclear charge were known (numerically), the energies of all possible stationary states of the single external electron could be computed. We must, in any case, find that the set of stationary states forms no longer (as with hydrogen) a single series of terms depending on an integer n, but a double series depending on two integers n and k. We find that with absolute confidence we can identify the sharp terms with those for which $k=1$, principal terms $k=2$, diffuse terms $k=3$, and Bergmann (fundamental) terms $k=4$. Moreover, on the correspondence principle,

only those combinations of terms will normally give rise to lines for which k changes by ± 1. This is precisely what is found to occur, and the puzzling incompleteness of Ritz's combination principle is entirely accounted for. There is, moreover, no real element of arbitrariness in this explanation, for the variation of the effective nuclear charge is of course due to the already bound electrons. These must lie in permitted orbits of definite quantum numbers which fit in with those of the spectral terms for an approximately central field of force, not very greatly modified from that which acts on the last electron. The numerical requirements of the theory can be satisfactorily met, and there remains no doubt that the atom must be regarded as fitting together in some such way. Perhaps this paragraph somewhat overstates the completeness of the theory as here expounded by Bohr, but it does not, I think, misrepresent it.

Besides its main contribution, the second essay also touches on and exhibits in their proper perspective other spectral facts—the spectra of ionised atoms, in particular those of the alkaline earths, with their Rydberg constant $4N$, which results naturally from the double residual charge with which the ionised atom controls its last electron; doublet and triplet separations, which arise from the deviation of the atomic field from central symmetry leading to the introduction of a third quantum number; finally, the unique nature of the helium spectrum with its absence of inter-combinations, of which an explanation in terms of a further generalisation of the correspondence principle may at least be said to be in sight.

These are mainly facts of which the explanation is still under development, but three further complete successes of the theory must also be recorded. The idea of stationary states accounts completely for the differences between emission and normal absorption spectra. An atom in its normal state can absorb only those lines for which the normal state is the initial stationary state of the absorption switch. For an alkali metal this means the principal series of doublets only—for an alkaline earth the principal series of singlets. In other cases, such as the aluminium subgroup, the theory leads us to expect that the normal state will correspond to the first principal term and that the absorption spectrum will be the sharp and diffuse series—an expectation recently confirmed by direct experiment. Secondly, the phenomena of resonance spectra are fully accounted for. Thirdly, the theory assigns definite energies to the various atomic states, and this assignment can be tested directly by the study of electronic impacts. This is by itself a complete branch of modern physics directly inspired by the theory, which it as directly and completely confirms.

The third essay, "The Structure of the Atom and the Physical and Chemical Properties of the Elements" (October 1921), is the most novel and important of the three. It differs from the others in being slightly revised in translation to bring it up-to-date (May 1922). This essay brings the whole of the available evidence—X-ray, chemical, optical—to bear on the specific question of the structure of the atom; that is, the way in which the planetary electrons are arranged. We have already seen that this is implicitly discussed, and a definite view reached, in connexion with the theory of series spectra. Other evidence merely confirms and crystallises this view. The goal to be attained is the theoretical deduction, from the principles of the quantum theory properly formulated, of the periodic table of the chemical elements, and all other atomic properties. Bohr shows that the fundamental process which must be considered is the successive binding of electrons one after another by a nucleus originally naked, and that, if we could say what would be the final orbit of the nth electron bound by a nucleus of charge Z, we could deduce the general features of the periodic table and other atomic properties in the desired manner. He shows that already we know, partly theoretically, partly empirically, a very great deal about these binding processes. The arguments cannot usefully be summarised. The result is that we can specify with considerable certainty the two principal quantum numbers, n and k, of the orbits in most atoms. The orbits thus fall into a number of groups, and we know the number of equivalent orbits in each group. The groups of orbits are arranged with various types of spatial symmetry; they must on no account be thought of, as in earlier models, as forming coplanar rings of electrons. The systematic study of X-ray levels begun by Kossel in the field opened up by Moseley has played a leading part in this development.

There are two crucial points to be emphasised in the present position of the theory, which can best be stated as questions. *Can we deduce from the quantum theory the particular points at which a group of electronic orbits fills and a new group starts?* In particular, can we prove that the third electron in the lithium atom must remain in a new type of orbit ($n=2$, $k=1$) and not fall into an orbit equivalent to those of the first two electrons ($n=1$, $k=1$)? Secondly, *can we deduce from the theory the regular sequences of physical and chemical properties, together with their occasional interruption for groups of homologous elements such as the iron group or the rare earths?* It can scarcely be said, and Bohr, I think, does not claim that an unqualified "yes" is yet the answer to the first question; but putting the question is itself a great advance, and the lines on which an answer will be forthcoming are already clear. It seems certain

that the impossibility of the third electron getting into a 1-quantum orbit is of the same nature as the impossibility of intercombinations in the helium spectrum or of the two coplanar electrons of the orthohelium spectrum getting both into coplanar 1-quantum orbits. These impossibilities seem to be connected with the absence of any coherent class of mechanically possible orbits which continuously connect together the initial with the desired final state, but the absence of such classes is scarcely yet established.

Granted the answer "yes" to the first question, the answer "yes" in general terms can now be given fairly to the second, though of course only a fraction of the interesting points of detail have yet been worked out. It can already be stated definitely that, for example, the iron group accompanies the establishment of orbits of type ($n=3$, $k=3$) in the normal atom which (it is almost a direct deduction) appear for the first time at scandium. They occur in the fourth period and differentiate it from the second and third because there for the first time is it arithmetically possible for successive atoms to differ by an extra electron in an inner orbit instead of in an external one. In the same way the rare earth group is associated with the development of orbits of the type ($n=4$, $k=4$), the outer orbits consisting of both 5-quantum and 6-quantum orbits, the same in number and much the same in form from atom to atom.

It is a great theory and a great work. Its most fruitful stages are yet to come.

R. H. FOWLER.

Religion and Evolution.

The Religion of Science. By Prof. William Hamilton Wood. Pp. xi+176. (London: Macmillan and Co., Ltd., n.d.) 6*s*. net.

AT the present time it is especially interesting to compare the way in which, in different parts of the world, thoughtful men regard the relation between religion and science. We should expect to find a general uniformity in the different attitudes of representative thinkers in Great Britain and America. We are largely of the same stock. We speak substantially the same language, so that books in large numbers pass in both directions across the Atlantic. But it is a curious fact that the popular religious dislike of evolution, which even enters into politics in the Middle Western States, affects leaders of American thought. No theologian of eminence in England would now challenge a scientific conclusion, for which experts combine to demand our assent. Yet, in the book before us, the professor of biblical history and literature in a college at Hanover, N.H., makes a vigorous attack on "the religion of science," and argues that man cannot be fitted into the scheme of biological evolution. *No fossil or organic half-man*, says the professor in impressive italics, *has ever been discovered, and never will be.* (Grammatically the final clause means the opposite of what the professor intends; but we will let that pass.)

Most readers of NATURE will be tempted to say at this stage, "The man's a crank. No need to read further." But the judgment would be unjust. Prof. Wood, though his literary style is at times painful, has clearly given close thought to the problems which he discusses. As against certain views expressed by American writers, in works with which we are unfamiliar, he argues acutely. He shrewdly exposes the illegitimate metaphysical assumptions of the "science-theology," which we should agree with him in condemning. But he has not apprehended the larger synthesis generally accepted by English theologians. Because his outlook is too limited, the theory of evolution seems to him to eliminate "God as a real existence and personality." So to preserve religion he rejects evolution.

This apparent necessity could not arise were there not a latent dualism in his thought. Christian theology in the third century took over from Neoplatonism a belief in the unity and solidarity of the universe. This belief, of course, is in fundamental harmony with the teaching of Christ. Failure to preserve it intact in all its implications is the source of most of the difficulties which have troubled Christian divines in their warfare with "science-theology." Prof. Wood is really following a degenerate tradition when he opposes the "natural" to the "supernatural" instead of pleading that in all Nature spiritual activity is manifest. His dualism causes him to speak of, "on one side, the non-moral development of the universe which is continuous, while within this, or related to it, is the moral evolution terminating in man." He can also say, "The main point is not whether mankind came originally from a single pair or was spawned like larvæ, nor is it our simian ancestry. It is that man is a derived and, therefore, secondary product." We need not comment on the biological character of the first sentence; but we would ask, Why should the derived product of the harmonious working of a universe, informed by Spirit, be secondary? Surely we should expect the creative activity of Spirit to work towards something of which it is the archetype; or, in more familiar language, that God has, by the slow process of evolution, created man for communion with Himself.

Prof. Wood does not see that, if Christian thinkers can justify their belief that the whole world arose and took its pattern because of the creative activity of Spirit, they need not quarrel with evolution. On the

contrary, the biological doctrine then becomes a description of the way in which Spirit has worked; and, by interpreting it, we get an understanding of the nature of spiritual reality. By tacitly opposing Nature and Spirit the professor finds it difficult to resist the conclusion that "the original and primal is the real." But if we are convinced that the process "from nebula to man" reveals Spirit working in time, we shall see, in Nature, degrees of reality which have successively emerged, the last being the consciousness of civilised man.

How can we meet the contention that there is no such reality as Spirit? We answer that the fundamental objection to the naturalism, which Prof. Wood terms science-theology, is that it is inconsistent with itself. It makes spiritual judgments while denying spiritual reality. Science, within its proper sphere, is quantitative. In it the mind abstracts those aspects of Nature which can be measured. But then the mind forms scientific concepts "in which the phenomena given in perception attain to a higher degree of coherence and of truth." We prize these concepts because of their truth-value. But value-judgments belong to the world of spirit, to a kind of existence to which merely numerical categories do not apply. To the same spiritual world such qualities as justice and virtue belong. Strictly speaking, they lie outside the realm of natural science. Men of science are always, often unconsciously, interpreting their results by means of value-judgments. Such a phrase as "the survival of the fittest" is a well-known example of this process. For the explanation of a thing or an event we have to use what is above it in the scales of existence or value. Yet, in spite of this, men of science who are constantly studying properties of matter, living or dead, jump to the metaphysical conclusion that matter is ultimate reality. The legitimate conclusion is rather that ultimate reality is spiritual, and that goodness and beauty, like truth, reveal its nature.

The relation of matter to spirit continues to perplex us. But the tendency of modern physics is increasingly to reduce matter to a mere metaphysical abstraction, like the ether, which is the subject of energy. Some physicists appear to regard matter as nothing but a form of energy. But neither view will allow us to regard the universe as a self-acting machine, for in such a conception mind can have no place. Moreover, as soon as natural science ceases to be merely descriptive, the idea of causation enters in. We cannot explain cause unless we admit creative action working towards a definite end, so that the laws of Nature express the uniform mode of action of a Supreme Will. The doctrine of evolution indicates the purpose of that Will, for it asserts that earth's life-process has led to man, whose conscience tells him that he must be loyal to absolute values external to himself. God, in short, reveals His own nature in the highest faculties of humanity.

It cannot, we think, be fairly argued that belief in evolution destroys the Christian hope of eternal life. That hope rests ultimately upon belief in "the conservation of values," upon a conviction that the attributes of God are eternal with Him. We now know enough of the universe to be sure that within a measurable period life upon this earth will come to an end. All humanity's spiritual achievements will then perish unless there is a Kingdom of Heaven where they are eternally preserved. Among such achievements the perfecting of personality ranks highest. It is difficult to conceive either of timeless existence or of a perfect human soul; but the reasonableness of our hope of eternal life is not thereby destroyed. Significantly Christianity connects belief in human immortality with its doctrine of the Incarnation, its affirmation that, in a perfect Man, God has actually been revealed.

We can do no more than hint at our reasons for disagreeing with Prof. Wood's point of view. But, because we have criticised his views, we would commend his honesty, his freedom from bigotry, and the high seriousness of his aim. The problems which have engaged his attention are as difficult as they are vital. It is probable that humanity will never solve them completely; it is certain that now we can but see "as in a glass darkly." E. W. BARNES.

A Peruvian Desert.

Geology of the Tertiary and Quaternary Periods in the North-west Part of Peru. By Dr. T. O. Bosworth. With an Account of the Palæontology by H. Woods, Dr. T. W. Vaughan, Dr. J. A. Cushman, and others. Pp. xxii+434. (London: Macmillan and Co., Ltd., 1922.) 2*l.* 5*s.* net.

THERE are few contributions to geological science, published in recent years, of greater value than this description of some three thousand square miles of the littoral of northern Peru.

Dr. Bosworth, who was formerly in the British Geological Survey, was still a young man when he left it to take up economic work, but he had already made himself a name for sound and original geological research. The present publication is not the result of a rapid traverse of the area with which it deals, but is the fruit of several years of exploration, reinforced by detailed surveys in many places and numerous borings for oil, in which the characters of the strata traversed were carefully observed. Dr. Bosworth has

had one great advantage; the desert conditions that prevail expose clearly to view much more of the characters and structures of the rocks than meets the eye in more fertile regions. At the same time, he has spared no pains to make his work as complete as possible. In order that the fossils collected should be properly described he has enlisted the services of a number of the leading palæontologists in this country and America, and their descriptions, figures, and conclusions are given in full.

The district described rarely exceeds a thousand feet in height above sea-level. It lies between the Pacific and a background of the Western Andes, which consist of pre-Tertiary rocks folded under the stresses of the zone of compression that encircles the greatest in the immediate neighbourhood of the shore, raised above its previous level. It was at the same time broken up into numerous blocks separated by minor faults, often of considerable throw, constituting a kind of fault breccia on a gigantic scale.

In this aggregate of dislocated sediments the action of the sea, assisted by subaerial agencies, excavated a broad, nearly horizontal shelf, which reached to the foot of the mountains, and became submerged sufficiently to allow of a new series of deposits being laid down upon it, which must be referred to the Quaternary Period, as they contain remains of forms identical with those living in the adjoining sea. Then a period of elevation supervened, and the former sea-floor was exposed to view as a nearly level plateau—a *tablazo*,

FIG. 1.—Ridge-and-furrow topography, produced where the strike of the beds is in the same direction as the prevalent wind. From "Geology of the Tertiary and Quaternary Periods in the North-west Part of Peru."

of our oceans. The latest strata involved in the folds are of Cretaceous age, and it must have been after their deposition that these mountains were raised up and exposed to the destructive activities of sun, wind, and running water, and in all probability frost and ice as well. From the debris a great succession of sedimentary strata of Tertiary age were accumulated to a thickness of some 20,000 feet on the slowly subsiding ocean floor, not without important breaks in the succession, for only the Eocene and Miocene are represented.

The denudation of the mountains and the accumulation of the sediments over a broad tract on the margin of the Pacific appear to have destroyed the isostatic balance that had previously existed and created a state of strain which finally resulted in a great fracture off the coast, the western side being thrown down deep below the surface of the sea, and the eastern, which included such of the Tertiary deposits as were as it is called locally—and it still remains in many places almost in the same condition as it was when the sea left it. Its western margin was now attacked by the waves and a second shelf was carved out, which was covered by another series of deposits, and afterwards raised to form a second *tablazo*. Still another *tablazo*, possibly more, would seem to have come into existence in the same manner. The last tracts to be raised from the sea were the *salina* or salt plains, which are scarcely above the reach of the spring tide. Indeed, some parts are occasionally submerged. Remains attributed to the Incas are found upon them, and some of the land a few hundred yards from the high-water line has been irrigated, apparently by them. It would seem therefore that there can have been no appreciable change of level since the coming of the Spaniards. The author infers that not a ten-thousandth part of the Quaternary history can have elapsed in the last five hundred years. This would give Quatern-

ary time a duration of at least five million years, which seems an over-estimate. In all probability the rise of the land has not been continuous, but rapid movements of elevation have alternated with long ages of quiescence, while the occasional periods of submergence may be explained by a slow continuous rise of the ocean level, such as is believed by Daly to have taken place in the Pacific. It is worthy of note that there appears to be no evidence of any renewal of compression since that to which the mountains owed their formation in late Cretaceous or early Eocene times. This suggests a doubt as to whether the westward movement of South America, postulated by Wegener, can have continued far into Tertiary times.

There is not space to follow the author in his description of the climatic conditions in the desert; of the effects of the rare torrential rains and the slow desiccation that succeeds; of the deeply cut valleys, the breccia fans, and the valley and marine terraces; of the work of sun and wind, and of the scanty animal and vegetable life; except to say that the book should take its place beside the writings of Walther and Cloos in the libraries of all students of the desert.

The concluding chapters contain a useful account of the petroleum deposits of the area, in which oil-wells have been sunk to a depth of 4000 feet. Valuable information is afforded as to the stratigraphical range of the oil, and the history of its exploitation is described; but it is unfortunate that in deference to the wishes of the International Petroleum Company no detailed account of the main oil-field is given. "With the exception of a few general comments, sanctioned by the Company, the development and conclusions of the past eight years are excluded from this description." Considering how much the great industrial organisations owe to science, one would expect from them a little generosity, even a little sacrifice of material advantage, if such be required, that they may repay their debt to research by adding their quota to the general fund of human knowledge.

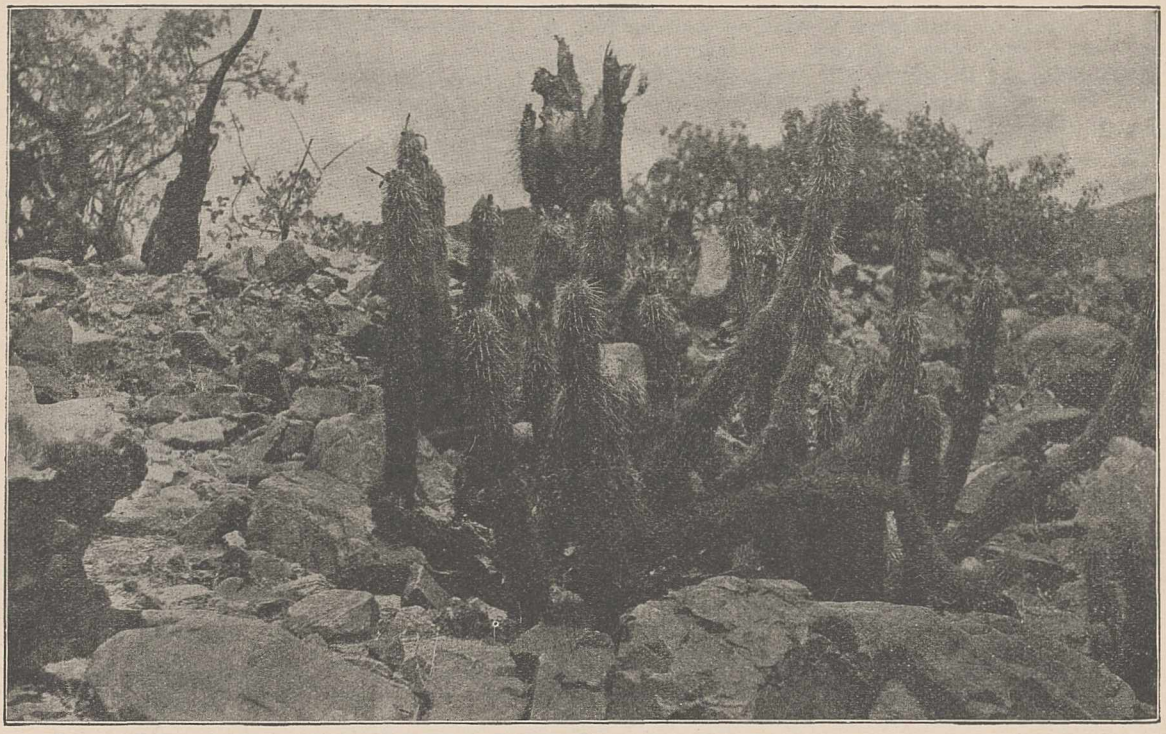

FIG. 2.—"*Rabo de Leon*" growing among blocks of quartzite in the Amotape Mountains. (The height of these plants here is about 3 feet.) From "Geology of the Tertiary and Quaternary Periods in the North-west Part of Peru."

It only remains to state that the book is excellently illustrated by numerous sketches and reproductions of photographs (two of which are given here) and by clearly-drawn maps, plans, and sections.

JOHN W. EVANS.

Our Bookshelf.

Aspects of Science. By J. W. N. Sullivan. Pp. 191. (London: R. Cobden-Sanderson, 1923.) 6*s.* net.

MOST works on that department of thought which lies on the frontier between philosophy and science should be included by pharmacologists among the class of narcotic drugs. As narcotics they are very effective, for they induce oblivion rapidly and profoundly, and they have the great advantage of being without any of the undesirable—or other—after-effects that are

common with such drugs. Notably, they have not the great drawback of most narcotics of inducing a craving for the constant repetition of the dose. Perhaps this character is partly determined by the circumstances in which these works are mostly used. Observation will confirm the general impression that such books are largely resorted to by elderly men of science, after working-hours, in the fastnesses of club libraries or by the domestic fireside. Mr. Sullivan's book is, however, useless for such purposes, for he defies slumber!

We do not remember to have read in English anything on the philosophical implications of science comparable to this little book for its wit. Easy writing is said to make hard reading, and, if the converse is true, an immense amount of labour must have been thrown into this series of very short chapters. Short though they are, many of them leave a feeling of remarkable completeness, and some of them, such as those on "Assumptions in Science" and "The Sceptic and the Spirits," are really little masterpieces in which we feel Mr. Sullivan has said the last word in the present state of knowledge.

There are many books on the nature of science and on its philosophical and ethical relationships, but there are very few that will appeal to younger people. Mr. Sullivan has, however, produced such a work. It can be safely placed in the hands of any student; most of it can be understood by any intelligent boy or girl of the age of sixteen; it is always challenging without ever being dogmatic, and witty without ever being cruel or "cheap." Any scientific man with the slightest philosophical bent must find this work stimulating and refreshing, and it is obviously written by one with a remarkably wide working knowledge of science.

C. S.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Abt. IX: Methoden zur Erforschung der Leistungen der tierischen Organismus. Teil 4, Heft 1: Methoden der Erforschung bestimmter Funktionen bei einzelnen Tierarten. Lieferung 76. Pp. 122. (Berlin und Wien: Urban und Schwarzenberg, 1922.) Grundzahl: 4·8 marks.

THE new section of Abderhalden's invaluable "Handbuch der biologischen Arbeitsmethoden" contains a very useful résumé of methods for the study of digestive secretions in the lower forms, an account of the technique of gonadectomy and transplantation of germinal tissue in insects, together with a rather longer review of experimental procedure in the study of pigmentary responses. This section, by Dürken, suffers, like the author's recent "Einführung in die Experimentalzoologie" (1919), from a complete disregard of the large volume of experimental work on amphibian metamorphosis and the illuminating observations on colour response which have emerged from it during the past eight years; consequently it deals exclusively with methods for studying factors which induce pigmentary responses rather than the mechanism which co-ordinates them. Perhaps it is inevitable that such omissions should occur owing to the economic handicaps under which scientific workers are pursuing their labours in Central Europe at the present time. Still, it is difficult to believe that the author of the "Methoden zum Studium des Pigmentwechsels" had no opportunities of consulting the extremely important work of Spaeth, Redfield, Smith, Allen, Laurens, and Swingle, none of whom is mentioned in his survey, though there have been since 1918 few numbers of the *Journal of Experimental Zoology* which do not contain some contribution to the physiology of pigment response in amphibia, reptiles, or fishes.

Infant Mortality. By Dr. Hugh T. Ashby. Second edition. (Cambridge Public Health Series.) Pp. xii+224. (Cambridge: At the University Press, 1922.) 15*s.* net.

BY "infant mortality" is meant the ratio which the number of infants who die in any one year bears to the number of births in that year. The rate for the country generally remained more or less stationary until 1905, since when, however, it has steadily decreased, so that during the last two or three years it has been only about half that which obtained in the late nineties of last century. Infant mortality is of enormous national importance, for with the present low death-rate, which it will be difficult in the future materially to reduce, and a falling birth-rate, now only about two-thirds what it was at the end of last century, the maintenance of our population will largely depend upon the survival of as large a proportion as possible of the infants born.

The appearance of a second edition of Ashby's "Infant Mortality" is therefore opportune. The practical side of the question has been kept in view throughout, and purely medical technicalities have been omitted. The condition is a very complex one, but an attempt is made to ascertain its main causes; one of these, summer diarrhœa, has been practically suppressed. The number of still-births and the mortality during the first week of life are still far too high, and their causes merit further investigation. Maternal mortality shows an actual increase of late, and needs to be taken seriously in hand.

The author has skilfully marshalled his facts, and the chapter on the means by which infant mortality may be further reduced gives an excellent summary of the subject.

Pests of the Garden and Orchard. By Ray Palmer and W. Percival Westell. Pp. 413+47 plates. (London: Henry J. Drane, Farringdon Street, n.d.) 25*s.* net.

IN the work under notice the authors have aimed at meeting the needs of practical agriculturists and horticulturists by collecting into one book all the available information on plant pests and diseases necessary for their guidance. Insects and other animals, fungus diseases and weeds, are all dealt with categorically under their separate headings, a short description and the methods of treatment being given in each case. Many of the numerous illustrations are very clear, but others are scarcely sharp enough to prove efficient aids to identification.

Among other useful features special attention may be directed to the detailed formulæ for sprays, with antidotes to the various poisons used in their composition, and also to the identification and spraying tables for insect pests and plant diseases. For identification

these are classified under the heading of the plant attacked, and the chief features of each are indicated with reference to the further descriptions in the text, whereas the spraying tables summarise the applicable methods of treatment with instructions as to the time they should be carried out. Altogether the practical man, and others, will find this a most useful handbook for obtaining much of the necessary information that is otherwise very scattered.

Business Geography. By Ellsworth Huntington and Prof. F. E. Williams. With the co-operation of Prof. R. M. Brown and Lenox E. Chase. Pp. x+482. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1922.) 13*s.* 6*d.* net.

THE authors intend this volume to be used after a course on commercial and industrial geography. It deals with the principles of geography, the effect of specific geographical factors, types of human communities, and the trade and commerce of the continents, with more detailed consideration of the United States. The book is a welcome addition to the volumes already available on the geography of production and commerce, and in its width of outlook and wealth of ideas should prove very stimulating, and occasionally provocative, to all readers. In one essential respect it differs from most books on the subject: the human factor in business relations receives ample consideration. The world is treated not merely as so many places, each producing so many products: the varying physical and mental qualities of races are recognised and given their due weight in the explanation of the development of the world. Stress is also laid on the relation of man to different climates in respect of wealth and efficiency. The book is admirably illustrated, and there are a number of ingenious exercises attached to each chapter. It is a book that should find wide acceptance in spite of its unattractive title.

Practical Colour Photography. By E. J. Wall. Pp. vii+248. (Boston, Mass.: American Photographic Publishing Co.; London: H. Greenwood and Co., Ltd., 1922.) 13*s.* 3*d.*

THE representation of colour, in addition to form and light and shade, by photographic means is a subject that has been allowed to get very far behindhand so far as text-books of photography are concerned. Mr. Wall's volume is therefore very welcome as doing a great deal towards filling this gap in photographic literature, which has been automatically increasing for many years. It does not quite fill the gap, for photo-mechanical methods are not treated of, historical and theoretical data have been, so far as possible, omitted, and the scope of the work has been restricted by the fact that all methods and formulæ given have been personally tested in practice. But within the limits indicated it is surprising how many methods there are of representing colour. Of three-colour processes there are the carbon and gum bichromate processes, the imbibition of dyes, mordanting processes, the bleach-out process, and the use of screen plates (autochrome, Paget). Of what may be called direct processes there are the interference heliochromy of Lippmann, the use of "silver subchlorides," and the diffraction and prismatic dispersion processes. Finally there are two-colour processes, and those adapted specially for cinematography. The book forms an excellent practical introduction to the subject.

Le Négatif en photographie. Par A. Seyewetz. Deuxième édition, revue, corrigée et augmentée. (Encyclopédie scientifique: Bibliothèque de Photographie.) Pp. viii+308. (Paris: Gaston Doin, 1923.) 15·40 francs.

M. SEYEWETZ is chiefly known to us by the researches that he has carried out, often in conjunction with M. M. Lumière. One naturally expects an author to treat more fully of those subjects that he has personally studied. In the present case this is a distinct recommendation, for the author's investigations have been so largely connected with the processes involved in negative making. The summaries of the characters, use, and effects of the various developing agents are especially valuable. It is of interest to notice that M. Seyewetz is not one of those who believe that development is a mechanical process which cannot be varied except to the detriment of the negative. The paper and the quality of the illustrations of this volume show that our neighbours have not recovered so far as we have in this country from the detrimental effects of the War, but these matters do not detract from the sterling character of the volume.

Practical Handbook on the Diseases of Children: For the Use of Practitioners and Senior Students. By Dr. Bernard Myers. (Lewis's Practical Series.) Pp. xvi+548. (London: H. K. Lewis and Co., Ltd., 1922.) 21*s.* net.

THE important subject of diseases of children is one which is too often neglected in the curriculum of the medical student. Dr. Bernard Myers has produced a handbook in which he has treated the subject mainly from the practical side. He has adopted the usual arrangement of considering anatomy and physiology first, then clinical investigations and the diseases of the various systems. Articles have been contributed by experts in their special branches, *e.g.* biochemistry, serum therapy, physiology of digestion, and syphilis. Some confusion may arise from the separation of nutritional disturbances from affections of the stomach and intestine, and also from the classification of nutritional disturbances as "failure to gain," "dyspepsia," "decomposition," and "intoxication."

The moderate size of the book, its concise descriptions and practical aspect, combine to make it a useful addition to the student's text-books and the practitioner's library.

Religion and Biology. By Ernest E. Unwin. (Christian Revolution Series, No. 15, Pp. 185.) (London: The Swarthmore Press, Ltd.; New York: George H. Doran Co., 1922.) 6*s.* net.

THIS work, written from the point of view of a member of the Society of Friends, is an attempt to outline the biological approach to questions of religious thought, and should be of use to school teachers. The author believes he has a message for biologist and schoolmasters. His gentle and spiritual point of view never raises opposition, and the book will be found of value for the purpose for which it is designed.

Letters to the Editor.

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

Crystal Structure of Basic Beryllium Acetate.

PROF. G. T. MORGAN recently sent me some well-formed crystals of basic beryllium acetate $Be_4O(C_2H_3O_2)_6$, suggesting that their analysis by X-ray methods would, in all probability, be of considerable interest. The results show, I think, that the anticipation was well founded.

The molecule is a perfect tetrahedron. The crystal structure is that of diamond, a molecule replacing each atom of carbon. The carbon atom is itself tetrahedral, but is very nearly a sphere. The slight departure from sphericity is shown by the presence of a very small second order in the reflection by the tetrahedral plane of diamond. In the acetate this effect is large, because the tetrahedral character is so much more pronounced than in the carbon atom.

The oxygen atom must be at the centre of the tetrahedron. The beryllium atoms lie on the lines from the centre to the corners; and each $(C_2H_3O_2)$ group must be associated in a very symmetrical manner with one of the tetrahedron edges.

Prof. Morgan and I hope to give, at a later date, a fuller description of the analysis, and to discuss the inferences that may be drawn from it.

W. H. BRAGG.

A Theory of the Viscosity of Liquids.

As is well known, the viscosity of gases and its variation with temperature has received a satisfactory explanation on the basis of molecular theory. Little progress has, however, been made towards explaining the phenomena of the viscosity of *condensed* media—that is, of liquids and solids from a molecular point of view. What is evidently required is a working hypothesis which will indicate why, when a substance passes from the state of vapour to that of liquid, its absolute viscosity is greatly increased but *diminishes* with rising temperature, while that of the vapour *increases* in the same circumstances. I propose in this note to put forward briefly the outline of a theory which appears to have claims to serious consideration, as it indicates a quantitative relation between the viscosity of a liquid and of the corresponding vapour which is supported by the experimental data.

The manner in which transverse stress is propagated through a material medium is known in the cases in which the substance is in the state of vapour and in that of a crystalline solid. In the former case, momentum is transferred through the diffusion of the molecules between parts of the medium in relative motion, and this is a relatively slow process. In the crystal, on the other hand, the stress is transmitted in the form of transverse elastic waves, and the latter process, at least for ordinary displacements, is extremely rapid. We may conceive that in a liquid, momentum is transported partly by the first process and partly by the second, and that the effective viscosity depends on their relative importance. The ratio in which the two modes of propagation are operative may be determined from thermodynamical considerations, combined with certain simple suppositions regarding the constitution of a liquid.

We shall assume that the state of aggregation of the molecules in a liquid is of a composite character: some of the molecules are quite free to move, and may be termed "vapour" molecules; the others are attached to each other somewhat as in a crystal, and may be termed "crystalline" molecules. In determining the proportion of the two types, we shall consider only binary encounters between molecules. Let E_1 be the work required to separate a pair of molecules of the first type, and E_2 those of the second type. Then applying Boltzmann's distribution law, we may, as a first approximation, take the relative proportion of the two types of aggregation in the dissociation equilibrium to be as $e^{E_1/RT}$ to $e^{E_2/RT}$, where R is the gas-constant and T the absolute temperature. The next step is to determine the rate of transport of momentum through the medium. In the "vapour" part of the aggregation, the transport occurs by bodily movements. In the "crystalline" part, the rate of transport may be considered to be practically infinite. The effective rate of transport in the liquid is therefore greater than in the vapour at the same temperature and pressure in the ratio $e^{E_2/RT}/e^{E_1/RT}$. The viscosity of the liquid is therefore given by the formula $\eta_{liquid} = \eta_{vapour}\, e^{(E_2-E_1)/RT}$. Since $E_2 > E_1$ it follows that the viscosity of the liquid will *diminish* with rising temperature.

The next step is to determine the absolute magnitudes of the energy constants E_1 and E_2. As was first pointed out by Sutherland, in the cases of gases and vapours the attractive forces between the molecules tend to *increase* the frequency of collisions and thus *diminish* the viscosity. The matter has been further examined by Chapman, who has shown that Sutherland's constant is one-sixth of the mutual potential energy of the molecules when in contact. It is convenient to use an amended form of Sutherland's formula and write

$$\eta_{vapour} \propto T^{\frac{1}{2}}\, e^{-E_3/RT},$$

where E_3 is another energy-constant. From Chapman's work it would appear that $E_2 = 6E_3$, and we may also take $E_1 = E_3$. Hence, finally, we have

$$\eta_{liquid} = \eta_{vapour}\, e^{5E_3/RT}.$$

E_3 may be found from the data for the viscosity of vapour at different temperatures, and the formula thus enables the viscosity of the liquid to be calculated *a priori*.

To illustrate the matter, it will suffice to take the case of benzene as an example. The table shows the viscosity of liquid benzene at different temperatures as determined by Thorpe and Rodgers, and also as calculated from an empirical equation of the type $\eta = Ae^{B/T}$.

VISCOSITY OF BENZENE LIQUID.

$A = 0{\cdot}0000951$. $B = 1237$.

Temperature.	Calculated Viscosity.	Observed Viscosity.	Difference.
7·67°	0·00781	0·00789	+8
13·46	0·00714	0·00717	+3
19·39	0·00654	0·00654	0
25·96	0·00595	0·00595	0
32·07	0·00549	0·00547	−2
38·47	0·00504	0·00502	−2
45·35	0·00464	0·00461	−3
51·66	0·00429	0·00429	0
57·37	0·00403	0·00402	−1
63·29	0·00377	0·00377	0
69·41	0·00353	0·00354	+1
73·36	0·00332	0·00333	+1

Viscosity of benzene vapour at 100° C. = 0·0000930.
$5E_3$ calculated from the value at 212·5° C. is 1300.

It will be seen that the formula represents the viscosity of the liquid within an average error of 2 parts in a thousand; and that the constants A and B are in fair agreement with the values calculated from the data for the viscosity of the vapour. An empirical formula of the type $Ae^{B/T}$ is found to represent closely the variation of the viscosity of many liquids, especially at the higher temperatures. As we have assumed that the "vapour" molecules are identical with those actually found in the gaseous state, we cannot expect the experimental constants A and B to agree exactly with those indicated by the theory outlined in this note in all cases. Considerable deviations actually occur in the case of "associated" liquids, in which presumably the effect of the molecular fields of force cannot be handled so simply.

The further discussion of this question and of the extension of the theory to the case of dense vapours on one hand, and to supercooled liquids and amorphous solids on the other hand, offers a most interesting field of research. The treatment suggested can obviously be improved in several directions, especially in the discussion of the dissociation equilibrium between the two types of molecules, and the effect of high pressures on the viscosity of liquids could probably be explained by a more exact investigation.

C. V. RAMAN.

210 Bowbazaar Street,
Calcutta, India, March 1.

Colour Temperature and Brightness of Moonlight.

OUR more complete knowledge of full or black-body radiation embodied in Planck's law makes it possible to speak of the temperature of radiation as well as the temperature of radiating bodies. Thus, the temperature of any visible radiation is the temperature to which a black body must be raised to emit light as nearly as possible of the same integral colour or quality as that of the radiation in question.

The necessary "colour matches" involved in comparisons of a given radiation with that of a black body at a known temperature may be easily and quite accurately made with a contrast photometer. Radiation temperatures thus determined are called "colour temperatures." The colour temperature of the zenith sun as seen from the earth, according to Abbot's bolometric data, which extend into the infra-red spectrum, is 5600° abs. If correction is made for the absorption of the earth's atmosphere, we get a value of 6500° abs. for the colour temperature of sunlight above atmospheric limits. When a contrast photometer is used for making "colour matches" to determine colour temperature, a black-body source at a corresponding temperature is necessary for comparison. To avoid the necessity of a comparison black body at very high temperatures, advantage can be taken of Planck's formula for black-body radiation for computing a distribution of intensities in the visible spectrum which will give the integral colour of the source under examination, as measured by an optical pyrometer with monochromatic screens.

This procedure was followed in some observations made to determine the colour temperature of moonlight. The disappearing filament pyrometer with blue and red glass screens was focused on one of the brighter portions near the centre of the full September moon, 1916, when near the meridian. These readings were repeated under nearly the same conditions a year later. The colour temperature found for moonlight on the two evenings in question agreed to within 50°.

With the same pyrometer data we can also determine the brightness temperature of the moon for a given wave-length; that is, determine the temperature of a black body which has the same brightness or intensity for the same small wave-length interval chosen for comparison. Thus, with a red glass screen transmitting an average or effective wave-length of 0·665 μ, we may determine the brightness temperature of the moon for this wave-length. It is also possible, from the data thus obtained and the brightness of a black body, to calculate the brightness of the moon in candles per square centimetre. Thus, knowing the illumination due to the sun, the reflecting power of the moon for sunlight may be calculated.

The data determined from these various observations and calculations are shown in the following table:

Colour temperature of moonlight .	4125° abs.
Brightness temperature (λ=0·665 μ)	1575° abs.
Brightness for total light . .	0·25 candles/cm.^{2}
Reflecting power for total light .	0·07

The difference in colour temperature between the sun and sunlight reflected from the moon, 5600° and 4125° respectively, indicates that the observed area of the moon reflects selectively, the coefficient being about twice as large at the red end of the spectrum as at the blue. The greater difference in brightness temperature of these two is due to the low albedo or average reflecting power of the moon's surface.

W. E. FORSYTHE.

Nela Research Laboratories,
National Lamp Works,
Cleveland, Ohio,
March 21.

Botanical Aspects of Wegener's Hypothesis.

IN the account which appeared in NATURE of January 27, p. 131, of the discussion on the distribution of life in the southern hemisphere, which took place before the Royal Society of South Africa, I am said to regard the botanical evidence as completely opposed to Wegener's theory. The remainder of the article generally followed the official report issued by the society.

My point was that the ancient phyla, with excellent means and ample time for dispersal, are generally valueless as indicating former land connexions. On the other hand, the distribution of the modern groups, especially the Angiosperms, in the South Temperate sub-continents took place in the main after the disruption envisaged by the Wegener theory. Thus neither ancient nor recent groups give us any material assistance in criticising this suggestive hypothesis, so far as concerns the relationships between the South American, South African, and Australasian floras. The botanical evidence for the southern hemisphere is certainly not "completely opposed" to Wegener's theory: it simply does not provide any critical test of that theory, so far as I can see at present.

R. H. COMPTON.

National Botanic Gardens,
Kirstenbosch, Newlands,
Cape Town,
February 26.

I ACCEPT Prof. Compton's correction of the phrase "completely opposed"; it is perhaps too strong a term to have used. Prof. Compton's letter, however, at least admits that the evidence from the botanical side is valueless as a critical test for or against

Wegener's hypothesis, and emphasises the fact that supporters of that hypothesis must look elsewhere than to the facts of animal and plant distribution for positive evidence in its support. Zoologists and botanists are dependent on the geologist and geophysicist for the correct interpretation of the palæogeographical changes which have taken place in the earth, and must be guided by them in selecting the basis on which the known geographical distribution of living forms can be explained.

THE WRITER OF THE ARTICLE.

Use of the Triode Valve in Spectrometry.

THE three-electrode valve offers a very simple and trustworthy method of amplifying the small currents produced in the thermopile of an infra-red spectrometer. Bright lines are more readily picked up and the limits of absorption bands determined with greater certainty with a valve and telephone than with a galvanometer. Moreover, the valve is instantaneous in action, while a sensitive galvanometer takes an appreciable time to give a trustworthy indication—so much so that the fainter lines are apt to be missed when using a long-period galvanometer. In the thermopile circuit an interrupter is necessary: this may take the form of a steel wire maintained in vibration electrically to which is attached a small wire dipper making contacts through a cup containing mercury. The interrupted thermopile current is passed through the primary of a small step-up transformer the secondary of which is connected to the grid of the valve.

For quantitative work the thermopile current is balanced by a potentiometer, a minimum of sound in the telephones indicating the point of balance.

The valve has a further advantage over the galvanometer in that it is unaffected by vibration or stray magnetic fields. The use of a valve for such work would seem to have many other applications, and to this end further experiments are being carried out.

L. BELLINGHAM.

71 Hornsey Rise,
London, N.19,
March 22.

The Release of Electrons by X-rays.

IN his interesting article, "Recent Advances in Photographic Theory," in NATURE of March 24, Dr. Mees touches upon the nature of X-rays and the mechanism of their production, and quotes Sir William Bragg's analogy of the plank of wood dropped into the sea.

I believe that Sir William Bragg put forward this analogy in a Robert Boyle Lecture, rather with a view towards successfully visualising the electron-X-ray process than of proving an individual relationship between them. One is tempted to say that an analogy never proves anything, although it may be thoroughly illuminating.

It is an extraordinary fact that a beam of X-rays will release electrons from an object which they hit, with just the velocity of the stream that originates the rays; it appears probable from energy considerations that this relation cannot hold down to the individual electron, so it might not be unprofitable if experiments were directed towards finding the limiting strength of the stream of electrons for the production of X-rays.

S. RUSS.

Physics Department,
The Middlesex Hospital, W.1,
March 26.

The Magnetic Disturbance of March 24–25.

A CONSIDERABLE magnetic disturbance occurred on March 24–25, as recorded by the Stonyhurst magnetographs. There was no marked sudden commencement of the disturbance, but the declination magnet began to move steadily towards the W., accompanied by a decrease in horizontal force, between the hours 8 and 9 G.M.T. The declination magnet attained the extreme limit of its westerly movement at 13 h. 14 m., when it began to move gradually towards the E. At 17 h. 12 m. a period of rapid oscillations commenced on the declination magnet. On the horizontal force magnet the decrease in force was succeeded, at 12 h. 24 m., by an increase. A very rapid oscillation of increase and decrease occurred between 17 h. 2 m. and 17 h. 18 m., the range being 88 γ ($1\ \gamma \equiv 10^{-5}$ C.G.S. unit).

A quieter period ensued on the declination magnet between 18 h. 24 m. and 21 h. 12 m., while the horizontal force magnet, after the rapid oscillation at 17 h. 2 m., showed a gradual decrease in force, which reached its limit at 18 h. 48 m. A remarkable rapid oscillation, to E. and return to W., occurred on the declination magnet, between 21 h. 12 m. and 21 h. 26 m., the range of the oscillation being 38′. This was accompanied on the horizontal force magnet by an even more noteworthy rapid oscillation of increase and decrease of force, of range 189 γ, between 21 h. 24 m. and 21 h. 50 m.

The only other notable feature of the disturbance was a bay in both elements, between March 25, 2 h. 12 m., and 3 h. 0 m., the range in declination being 16′, and in horizontal force 97 γ. The more violent phases of the storm had ceased by March 25, 8 h. The extreme ranges were, in declination 1° 6′, and in horizontal force 238 γ. The vertical force magnet showed a general movement, with oscillations, of increase and decrease of force between the hours March 24, 17 h. 12 m., and March 25, 4 h. 24 m. This would indicate the period of the greatest activity of the disturbance. The sensibility of the magnet is uncertain, but the extreme range was about 80 γ.

A disturbed period in magnetic activity occurred on February 25–28, so that this storm follows after an interval of 27 days, the synodical rotation period of the sun. But the solar surface has been unusually quiet during the past two months, at least so far as spots, which have been very few and of small area, and faculæ, which have been very faint, are concerned. The connexion of these disturbances with solar phenomena will require further elucidation. Father Dechevrens, *S.J.*, recorded strong earth-currents at his observatory, St. Louis, Jersey, during the February disturbance. It will be interesting to hear of any observations of aurora borealis.

A. L. CORTIE, *S.J.*

Stonyhurst College Observatory,
April 3.

Pressure of Fluidity of Metals.

MR. HUGH O'NEILL, in his letter in NATURE of March 31, p. 430, gives what he calls H_u, the "ultimate hardness" of tin, zinc, and steel. On referring to my letter at p. 17 of NATURE of January 6, it will be seen that H is there used for H_u, and that the pressure of fluidity = *twice* the ultimate hardness. The units of H_u given at p. 430 are evidently kilograms per sq. mm. Expressing these in kilos per sq. cm. and multiplying by 2 we obtain the following values of the pressures of fluidity as calculated by Mr. O'Neill

by means of his equation given at p. 773 of NATURE of December 9, 1922.

Metal.	Pressure of Fluidity.
	Kilos per sq. cm.
Tin	1,080
Zinc . . .	5,000
Steel A . . .	19,200
Steel S90 . .	33,600

I have recently (with the generous aid of Mr. R. H. H. Stanger of the Broadway Testing Laboratories, and the following firms who prepared and presented the necessary three specimens of each metal) determined the pressures of fluidity of several metals by direct experiment, so it will be interesting to compare the results, remembering of course that the specimens were *not* made from the same piece of metal as those used by Mr. O'Neill. In the case of my tests the three specimens of each metal were made from the same piece.

The British Aluminium Co. Ltd. supplied the specimens of aluminium.

Messrs. David Colville and Co. Ltd. supplied the specimens of mild steel.

Messrs. Dewrance and Co. supplied the specimens of tin, lead, and zinc.

The Elliott's Metal Co. Ltd. supplied the specimens of copper.

The Muntz's Metal Co. Ltd. supplied the specimens of Muntz's metal.

The experiments were made not merely to determine the pressures of fluidity, but also to test an hypothesis to account for the phenomenon of pressure of fluidity. This hypothesis is far too long to reproduce here, but it will be found in the Transactions of the Society of Engineers for the quarter January-March 1923. It connects the pressure of fluidity with the ultimate shearing and tensile strength of the metal, and was devised in connexion with experiments with clay, and then found to apply to plastic metals as well.

If p be the pressure of fluidity in kilos per sq. cm.,
f be the shearing stress in kilos per sq. cm.,
c be the ultimate tensile strength in kilos per sq. cm.,
then the hypothesis shows rationally on the assumptions made that

$$p = 3{\cdot}68c + 5{\cdot}21f. \quad . \quad . \quad . \quad (1)$$

The pressures of fluidity were determined by means of cylindrical specimens 70 mm. in diameter and 70 mm. high, using a flat-nosed punch 10 mm. in diameter at the end and reduced in the shank to 9 mm. so as to clear the sides of the hole.

Metal.	Tensile Strength c.	Shearing Strength f.	Pressure of Fluidity p.	p' the calculated Value of p.	$\frac{p'-p}{p'}\times 100$.
Lead . . .	114·5	125	777	1,072	+27·5
Lead-tin alloy	244·0	156	1,233	1,706	+27·7
Tin . . .	223	232	1,367	2,025	+32·5
Aluminium .	827	577	4,015	6,045	+33·6
Copper . .	2192	1445	10,860	15,590	+30·1
Muntz's metal	3686	2004	(16,800)*	23,966	
Mild steel .	4380	2990	(22,140)*	31,625	Mean +30·3
Zinc . . .	214	755	[7,760]	4,707	..

All stresses are in kilograms per sq. cm.

* These are *not* experimental values, but merely predictions.

The relation given by equation (1) thus on the average gives results which need reducing by 30 per cent. to arrive at the actual values, and the maximum departure from this mean is 3·3 (aluminium).

Zinc is a rank outsider as regards this hypothesis! But zinc has no plasticity. It did not elongate or show any contraction of area under a tensile force. In shear even it failed by tension, and when the pressure of fluidity experiment was made, the specimen gradually burst by yielding in tension on several vertical planes.

With regard to the variation of the figures in the last column, it must be remembered that these depend on the experimental values of f and c, which themselves vary. For example, in the case of the shearing tests, two experiments were made with each metal, the planes of shear being about one inch apart on the same specimen. For all this the values of f differed by 4·3 per cent. and 5·5 per cent. in the cases of tin and aluminium respectively.

A. S. E. ACKERMANN.

17 Victoria Street, Westminster, S.W.1,
March 31.

Use of the Millibar in Aerodynamics.

THE millibar, introduced by Sir Napier Shaw into British meteorology, brings the same drastic simplification into the numerical relations between pressure and velocity in aeronautics.

The accompanying diagram (Fig. 1) shows the

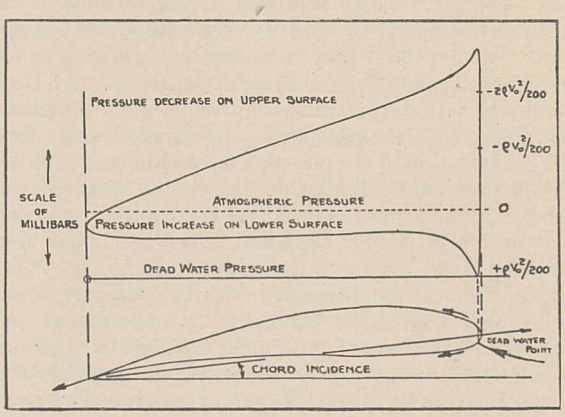

FIG. 1.

pressure distribution round a wing profile, calculated in accordance with Joukowsky's theory.

In C.G.S. units $p - p_0 = \frac{1}{2}\rho \cdot (v_0^2 - v^2)$ dynes/cm.^{2} or microbars, where p, v are the variable pressure and velocity at points on the profile, p_0, v_0 the values at a distance, and ρ the density of the air.

Expressing ρ and v in M., Kg., S. units, which are more convenient for aeronautical measurements,

$$\begin{aligned}\text{pressure} &= \tfrac{1}{2}\rho \cdot (v_0^2 - v^2)\ \text{m.kg.s.}^{-2}\text{m.}^{-2} \\ &= \tfrac{1}{2}\rho \cdot (v_0^2 \cdot 10^{-2} - v^2 \cdot 10^{-2})\text{mb.} \\ &= \tfrac{1}{2}\rho \cdot 10 \cdot (v_0^2 \cdot 10^{-2} - v^2 \cdot 10^{-2})\ \text{megadynes/m.}^2.\end{aligned}$$

The last two forms lend themselves to computation, since flying speeds usually lie between 10 m./s. and 100 m./s. The absence of all extraneous factors save integral powers of ten is sufficient proof of the practicality of Sir Napier Shaw's action.

In the minority of cases where the forces considered are produced by the action of gravity on known masses, they are easily transformed, for the megadyne is $10/9{\cdot}81 = 1{\cdot}02$ kgm. weight, and the millibar is $1000/981 = 1{\cdot}02$ cm. head of water with an accuracy amply sufficient for aeronautical measurements.

A. R. LOW.

London, March 22.

The Sun-Cult in Ancient Egypt.[1]

By AYLWARD M. BLACKMAN, D.Litt.

II.

IT has often been maintained that the Aton-cult instituted by Ōkhnatōn (Amenōphis IV.) displays non-Egyptian features and is in a large measure the product of foreign influences. I hope, however, clearly to show here that in the main it is the outcome of certain tendencies of the old solar religion discussed in the previous article — tendencies which had begun to manifest themselves so far back as the Old Kingdom, which came increasingly into evidence during the Middle Kingdom and the eighteenth dynasty, and finally found in the teaching of King Ōkhnatōn a somewhat particularised expression.

It was pointed out in the first article that the sun-god, owing to the political and religious importance of Heliopolis, became at a very early date the State-god of Egypt, and that the priests of a number of the local gods, in order to enhance their prestige, identified them with the sun-god, the goddesses who were associated with these gods being identified with Ḥathor, the sun-god's consort. There was also, it must be noted, a distinct tendency to identify the various divinities with one another, thus considerably reducing their number as separate entities in the Pantheon. All this, combined with the prevailing uniformity in the structure and equipment of the temples, the temple liturgy, and the organisation of the priesthood—a uniformity due to the predominant influence of Heliopolis—fostered the growth of monotheistic or, anyhow, henotheistic ideas.

During the Middle Kingdom, when a Theban line of kings ruled over a united Egypt, Amūn, the local god of Thebes, was identified with the sun-god, being henceforth known as Amunrē'. As a result of the imperial expansion of Egypt under the Theban emperors of the eighteenth dynasty, the sun-god, originally the national god of Egypt and the prototype of the Egyptian Pharaoh, became in the person of Amunrē' a world-god and a world-ruler. Thus the victorious Tethmōsis III. says of Amunrē' that "he seeth the *whole world* hourly." A hymn in praise of the sun-god, written in the reign of Amenōphis III., the father of Ōkhnatōn, speaks of the sun-god as "the sole lord taking captive all lands every day, as one beholding them that walk therein." The once merely national god has thus become a deity who exercises universal sway and possesses universal vision.

But the god of this hymn is not only the all-powerful, all-seeing ruler: he is also the beneficent protector and sustainer of mankind—"the valiant herdsman who drives his cattle, their refuge and the giver of their sustenance." It will be remembered, of course, that the sun-god appeared already in the literature of the seventh to eighth dynasties in the guise of "the shepherd (or herdsman) of all men." This same hymn further emphasises the sun-god's beneficent nature in calling him "a mother, profitable to gods and men." As is so frequently maintained in the religious literature of the Imperial Age, this hymn also asserts that the sun-god is the source of all, including his own, being. "Thou art the craftsman shaping thine own limbs; fashioner without being fashioned."

From this and other compositions it can be seen that the religious thought of the period just preceding the reign of Ōkhnatōn was distinctly monotheistic in its tendency. It was only necessary to advance this tendency a step or two further to arrive at actual monotheism. This is what Ōkhnatōn did when he asserted definitely once and for all that the sun-god was not only the supreme and universal god, but also the only God—an assertion that had never been definitely enunciated by the theologians who had preceded him, but had only been sporadically and somewhat vaguely hinted at by them.

The universality of Ōkhnatōn's god is clearly set forth in the famous hymn, which so closely resembles the 104th Psalm, and of which the king claims, probably with right, to be the author. The sun-god is represented as the All-Father, the source of all life. He it is who has created the different nations and assigned them their divers complexions and languages. He has also provided for their sustenance, making the Nile to well up out of the nether world to water the land of Egypt, but setting a Nile in the sky for other peoples, whence it comes down as rain. "Thou didst make the distant sky in order to rise therein, in order to behold all that thou hast made. . . . All men see thee before them, for thou art Aton of the day aloft."

There has been a certain amount of controversy as to whether Ōkhnatōn was actually himself responsible for the establishment of this monotheistic sun-cult. As has been stated at the beginning of this paper, some scholars incline to the view that the Aton-cult is distinctly of foreign origin and that its being established as the State-religion was due to the influence of Tyi, herself a foreigner, by whom her son Ōkhnatōn was completely dominated. Others, again, have maintained that the establishment of this cult was due to the successful intrigues of the Heliopolitan priests, who, attaining the ascendancy over a weak king, temporarily regained the religious hegemony of Egypt.

Those who take the view that the religious revolution was the work of Tyi and foreign influences, or of an intriguing priesthood, find the main support for their respective theories in the fact that the body, supposed to be that of Ōkhnatōn, is that of a man who could not have been more than 25 to 26 years old when he died, while the skull shows distinct signs of hydrocephaly, indicating that the person in question was weak intellectually. As Ōkhnatōn is known to have reigned for more than sixteen full years, he can, if this is his body, have been only ten or eleven years old when he came to the throne and the religious revolution began, and only sixteen or seventeen when he definitely broke with the priests of Amūn, changed his name from Amenḥotpe to Ōkhnatōn, and deserted Thebes and founded his new capital at El-Amarna. Yet before this change in name and residence two of his daughters, as a relief distinctly shows, were old enough to accompany him when he officiated at the temple liturgy, and, moreover, before the aforesaid change

[1] Continued from p. 502.

took place, *i.e.* before the sixth year of his reign, we happen to know that Ōkhnatōn celebrated the so-called *sed*-festival, a festival marking the 30th anniversary of the Pharaoh having been designated heir to the throne. Had it not been for the age-limit imposed by Ōkhnatōn's supposed body, we should naturally have imagined, in view of this last piece of evidence, that when he succeeded his father, Amenōphis III., he must have been at least 24 or 25 years old.

As a matter of fact, however, though the coffin in which the body was found was beyond question made for Ōkhnatōn, yet the body itself is almost certainly not his, the date of the objects found thereon, as Prof. Sethe has recently shown, precluding that possibility.

There can be little doubt, therefore, that Ōkhnatōn was a full-grown man when he came to the throne, while at the time of his break with the priests of Amūn and his shifting of the capital to Middle Egypt he was more than 30 years old, and accordingly at the height of his intellectual and physical vigour. The fact that Ōkhnatōn's supposed body is not his at all also disposes of the theory that he was weak mentally. There is, therefore, no necessity whatever to suppose that the new faith, which contemporary records so closely associate with the person of the king and which he was certainly quite old enough to have formulated, was the product of foreign influences during a regency of Tyi, nor yet of the Heliopolitan priesthood struggling for a religious and political supremacy. That Ōkhnatōn really was a man of exceptional mental gifts and high ideals—Breasted calls him "the first individual in history"—is evident from that remarkable portrait of him found at El-Amarna in 1912 and now in the Berlin Museum. All who see it are impressed by the beauty of the features and expression, the thoughtfulness pervading the whole countenance.

We need not, however, go to the other extreme, as some writers have done, and regard the love of righteousness and the beneficence attributed to Ōkhnatōn's god as primarily the expression of the king's own ideas and feelings. On the contrary, as has been pointed out in the preliminary article, these are the very qualities assigned to the old Heliopolitan sun-god. How far, indeed, the old solar religion had advanced in these particular directions, even before the Middle Kingdom, is especially evident in a literary composition of the ninth to tenth dynasties, to which by an oversight no reference was made in the above-mentioned article. In one portion of the work in question the ancient writer speaks of men as "the flocks of God (*i.e.* the sun-god)." God, he goes on to say, "made heaven and earth at their (*i.e.* men's) desire. He checked the greed of the waters, and made the air to give life to their nostrils. They (men) are His own images proceeding from His flesh. He arises in heaven at their desire. He sails by (*i.e.* in the celestial solar barque) in order to see them. . . . When they weep He heareth. . . . How hath He slain the froward of heart? Even as a man smiteth his son for his brother's sake. For God knows every name."[2] In the preceding section of the same work we read that "more acceptable (to the sun-god) is one righteous of heart than the ox of him who doeth iniquity."

That Ōkhnatōn's sun-cult is nothing more than a special development of the older sun-cult becomes only more evident the further one pursues one's researches. In the earliest stage of the cult the god appears simply in the guise of the Heliopolitan sun-god, Rē'-Horus of the Two Horizons (Rē'-Harakhte), with whom indeed, as we shall see, he was actually identified. As such he is depicted as a human figure with a hawk's head surmounted by the uræus-encircled sun's disk. Later on, however, but before the migration of the court to El-Amarna, the mode of representing the god was entirely changed. He was depicted as a solar disk, from which descend rays terminating each in a human hand—these hands being the only trace left of the old anthropomorphism, if they are not, as is quite likely, simply an expression of poetic fancy. The uræus was also retained, sometimes hanging from the disk, generally, however, rising up from the bottom edge towards the centre, though it was of no religious significance, but merely the emblem of kingship—Ōkhnatōn's deity being not only the world-god but the world-king.

The name of the new god in ordinary everyday parlance was *pa Aton*, "the Aton," aton (*itn*) being the word used then and earlier to denote the visible, physical solar body, though, as Sethe points out, the word seems occasionally to have been employed, even before Ōkhnatōn's time, to designate the sun-god himself. Generally, however, it just denotes the sun as a natural phenomenon or cosmic body, as distinguished from the god dwelling in it, a sense in which the word Rē' is never used.

According to the old theological teaching the physical sun was simply the embodiment of the god. Thus we read of "Atum (the sun-god) who is in his *aton*," "Rē' whose body is the *aton*," and him "who lightens the Two Lands (Egypt) with his *aton*." In fact, it was exactly on account of the very definite meaning of the word *aton*, Sethe maintains, that Ōkhnatōn chose it as the designation of his god; for the new religion was entirely materialistic in its conception of the Supreme Deity, in marked contrast to the—it must be confessed—much more spiritual conception of the old religion. Indeed it is just here that Breasted has gone astray when he asserts that "it is evident that the king was deifying the force by which the sun made itself felt on earth,"[3] an assertion that is based on a mistranslation of the Aton's official nomenclature (see below). On the contrary, it was the actual cosmic body, the physical sun itself, not a mysterious power incorporated in it or working through it, which Ōkhnatōn made his subjects worship.

In addition to the ordinary name, the Aton, the god also bore an official or formal designation, the words composing it constituting a short profession of faith—a compressed creed. This designation, which, on account of the god's world-wide kingship, was, like the two names borne by every Pharaoh, enclosed in two cartouches, appears in two forms, an earlier and a later. The earlier, which dates from the very commencement of the reform, and continued in use until after the seat of government had been moved from Thebes to El-Amarna, is as follows:—"Liveth Rē'-

[2] A. H. Gardiner, "New Literary Works from Ancient Egypt," in *Journal of Egyptian Archæology*, vol. i. p. 34.

[3] Breasted, "Development of Religion and Thought in Ancient Egypt," p. 321.

Horus of the Two Horizons, rejoicing in the horizon, in his name Shu who is Aton." The new god is thus identified with the two forms under which the sun-god was known both before and after the reign of Ōkhnatōn —Harakhte (=Horus of the Two Horizons) and Shu. The epithet "rejoicing in the horizon" is not, Sethe points out, an invention of Ōkhnatōn's, but appears earlier in the eighteenth dynasty as a description of the sun-god. Shu, originally personified space, was, as Sethe also points out, a common appellation of the sun-god from the Hyksos period onwards, and never (certainly not as written in this cartouche with the sun-determinative) can be used in the sense of "heat" or "splendour," as Breasted and Erman respectively have supposed. Sethe rightly maintains that the prominent feature in this official nomenclature is the element Rē'-Harakhte, the name of the Heliopolitan sun-god, all the rest, even the name Aton, being purely subsidiary.

The later official designation, which came into force apparently soon after the eighth year of the king's reign, is marked by certain significant changes. It runs as follows:—"Liveth Rē', the ruler of the Two Horizons, who rejoices in the horizon, in his name Father of Rē', who has come as Aton."

It will be seen that Horus and Shu, names which Ōkhnatōn perhaps thought were too definitely associated with the old religion, have been struck out and replaced by two epithets, "Ruler of the Two Horizons" and "Father of Rē'." The name Rē', which has not been interfered with, had been, as Sethe points out, a regular element in the Pharaoh's first cartouche ever since the fifth dynasty, and as such was of no theological significance. Also the king evidently had no objection to this old name of the sun-god. For example, he still retained the royal title Son of Rē'; Rē' appears as an element in his own first name and in the names of his two daughters; two temples or shrines associated with his mother Tyi and his daughter Meritaton bore the name "Shade of Rē'"; and the king himself, like other Pharaohs, is officially spoken of as Rē'.

The element "Father of Rē'" in the god's official designation is interesting, taking as it does the place of Shu. Shu, according to the old Heliopolitan theology, was the son of Rē', and as such he actually was assigned that title. It would, Sethe suggests, have been scarcely tolerable to the founder of the new religion that Aton, the creator and author of all being, should be regarded as the son of Rē', the sun-god of the old religion. Ōkhnatōn therefore asserts that his god is the father of Rē', *i.e.* he makes him cosmically older. The fact that the god is called Rē', and, at the same time, the Father of Rē', reminds one of the old epithet of Amūn, Bull of his Mother, which simply means that he is self-created, that is, that he was not begotten by another. Sethe rightly maintains that though this epithet has a polytheistic touch about it, Ōkhnatōn would have been as little conscious of this as were the Christian Fathers when they formulated the doctrine of the Blessed Trinity.

Sethe directs attention to another very interesting point in this later designation of the god. "To come," he says, "has obviously here, as so often, the meaning of 'to come again.' The Father of Rē' in question is thought to have come again after he had obviously disappeared or had been mistaken for another through man's ignorance, and indeed he has come again in the form of the apparently new but in reality primæval god of Amenōphis IV."

Let us now consider briefly the temples of the Aton erected at El-Amarna and the liturgy celebrated therein. The main difference between the temples of the Aton and those of the old Solarised religion lies in the fact that the former seem to have been roofless. There were thus no columned halls and dark, mysterious sanctuaries with their surrounding chambers, the place of these being taken by a series of main and subsidiary courts lying behind the forecourt and leading one out of another. The reason for this architectural change was that Ōkhnatōn permitted no cultus-image of his god to be made, not because he was an iconoclast or afraid of idolatry, but because his conception of God was so intensely materialistic. The Aton, as already pointed out, was the actual physical sun, the cosmic body itself, not a divinity dwelling in that body and manifesting himself through it, and therefore ready similarly to manifest himself through a cultus-image, which was "the body" of the divinity it represented, according to the ideas of the ancient theologians—as we should express it, the divinity's embodiment. Offerings had, therefore, to be made direct to the god in the sky, a procedure which necessitated a roofless temple, for no roof must intervene between the god and the offerings held up to him and laid on the altar.

Despite this complete break with the old conception of the indwelling presence of the god in the temple-sanctuary,—a conception which brought the god so near to his priests and worshippers—it is remarkable how closely in many respects the general plan and equipment of the traditional Egyptian temple were adhered to, a clear indication that there were no direct foreign influences at work in the new religion; indeed, the architecture down to the very last detail is purely Egyptian. We still find the pylon with its two beflagged towers and the great forecourt with its large stone altar in the midst[4]—the forecourt being colonnaded in the case of the temple bearing the name of "Shade of Rē' of the Queen Mother, the Great Royal Wife, Tyi." Evidently, too, the rearmost court of all in the Aton-temples, which occupied the place of the sanctuary in the ordinary Egyptian temple, was regarded as particularly sacred. Again statues of the king and also of the queen were set up as heretofore in different parts of the temples, the king and queen being thus enabled, so it was thought, to function perpetually as worshippers and offerers, or conversely as the recipients of worship and offerings. Yet again, before the entrance to what N. de G. Davies calls "the inner temple" of the Aton stood eight tanks of water for the purification of those who entered it. Such tanks or pools of water were, as pointed out in the preliminary article, a characteristic feature of the old Heliopolitan sun-cult. Finally, the "inner temple" was called the House of the Benben, the *benben* being, as we have seen, the sacred pyramidion in the great sun-temple at Heliopolis. Curiously enough, in the representations we possess of Ōkhnatōn's Aton-temples,

[4] By an oversight no reference was made in the account of an ordinary Egyptian temple, given in the preliminary article, to the stone altar that always stood in the colonnaded forecourt.

no obelisks (which were so closely associated with the old sun-cult) are depicted as standing before the main entrance or elsewhere in the sacred precincts. However, we know that Ōkhnatōn erected an obelisk in honour of Harakhte-Aton at Karnak, probably in connexion with his *sed*-festival celebrations.[5]

The Aton-temple liturgy itself is clearly the old temple liturgy adapted to the new ideas and new requirements. As there was no cultus-image, there was no place in the new worship for the toilet, or indeed many of the pre-toilet, episodes of the old liturgy. The worship of the Aton seems to have consisted mainly in the presentation to the god of food- and drink-offerings, perfumes, and flowers, and in the chanting of hymns and in musical performances in general. But the ceremonies connected with the presentation of offerings were those of the old religion, the officiant consecrating the offerings in the time-honoured fashion, *i.e.* by extending over them the so-called *kherp*-baton. As in the old liturgy, this ritual act was preceded by the burning of incense and the pouring out of a libation of water; indeed, the burning of incense and the pouring out of a libation were, as in times past, the regular accompaniments of every act of offering. The liturgy was celebrated, as of old, to the accompaniment of the rattling of sistra, and also of other musical performances, vocal and instrumental. Lastly, it should be pointed out, the ceremony of sweeping the floor—the removal of the foot-prints—before and after the celebration of the liturgy seems almost certainly to have been retained.

This article cannot be satisfactorily concluded without a brief discussion of two important questions that have already been touched upon in the preceding paragraphs, namely, Ōkhnatōn's quarrel with the priests of Amūn, and the theory advanced by some scholars that in the establishment of the Aton-cult we are to recognise a temporary restoration of the political and religious supremacy of the Heliopolitan priesthood.

Long before the time of Ōkhnatōn the Theban god Amūn had been completely identified with the Heliopolitan sun-god. What, then, was the cause of the king's rupture with the priests of Amūn and his breaking away from all Theban influences?

It must be borne in mind that the monotheistic tendencies of the preceding period had in no way affected the customary performances of the old institutional religion. Whatever may have been the speculations and ideas of the learned and enlightened few, the worship of the gods was conducted in exactly the same way as it had been for centuries, without a single hint at a change in the traditional ceremonial. Ōkhnatōn's religious revolution, on the other hand, not only entailed a great change in the conduct of the temple services and far-reaching structural alterations in the temple buildings, but also, since the king would brook no rival to his god, the suppression of all the festivals and other performances connected with the provincial cults and with the various cults established at the capital. All this was a completely new attitude in Egyptian religious experience; indeed we are encountering the "jealous God" for the first time in human history, several centuries before His appearance among the Hebrews. The feelings both of the priests and of the masses of the people must have been deeply stirred by this attack on their religious observances, particularly in so far as it affected the festivals celebrated in honour of the local divinities, festivals which no doubt played as great a part in the lives of the people as do those celebrated in honour of the local Egyptian saints at the present day.[6] In fact, there can be no question that Ōkhnatōn's reform meant far too sharp a break with the past for his intensely conservative-minded subjects.

It should here be pointed out that so early as the reign of Tethmōsis III. all the priesthoods of Egypt had been combined in one great organisation, with the high-priest of Amūn at their head. To the high-priest of Amūn, therefore, and to the priesthood of Amūn as a whole, all the local priesthoods would have looked to champion their threatened rights, while in Ōkhnatōn's eyes this very high-priest and priesthood would have appeared as the embodiment of all the forces of reaction against which he was struggling. Herein lay quite sufficient cause for his breaking away entirely from Thebes and the Theban god. We must also remember that Ōkhnatōn's materialistic conception of the Aton was entirely opposed to the—as already pointed out—much more spiritual conception of the sun-god formulated by the theologians of the old religion. It was impossible to regard the actual corporeal and localised divinity, such as Ōkhnatōn maintained his sun-god to be, as capable of identification with a being (or beings) who could manifest himself (or themselves) in all manner of forms and in many places. Did the cause of the final rupture reside in this difference of conception as to the nature of the Godhead? If so, we have here a foretaste of those great theological controversies which troubled the Christian Church of the first five centuries, and of the seventeenth-century wars of religion.

Let us now briefly consider the theory that in the institution of the Aton-cult we are to recognise the restoration of the political and religious supremacy of Heliopolis. In view of all that has been set forth in the preceding paragraphs, the Heliopolitan sun-cult is clearly to be regarded as the basis of the new religion, or rather as supplying all the material out of which the new edifice was constructed. On the other hand, the particular shape that that edifice assumed must be regarded as the work of Ōkhnatōn. If the sun-cult had been officially promulgated by the organised priesthood of Heliopolis or, as Borchardt[7] suggests, of Hermonthis (Heliopolis of Upper Egypt [*Ỉwnw šm*ʿ]), Ōkhnatōn, instead of founding an entirely new capital at El-Amarna, would have been obliged to install the seat of government in or very near the actual official centre of the religion he had adopted. But he was able to act as he did, because the religion he professed was regarded as a completely new religion, a special revelation to himself, as he distinctly asserts. It was therefore not associated with any particular locality, so he was free to make his capital in any place that seemed to him to be most free from the old traditions and best adapted to his requirements.

Lastly, just a few words on the frequently-made assertion that foreign influences are discernible in the

[5] Schäfer in *Amtliche Berichte aus den preuszisch. Kunstsammlungen*, xl. 10, col. 227.

[6] See W. S. Blackman, "Festivals celebrating Local Saints in Modern Egypt," in *Discovery*, vol. iv. No. 37, pp. 11-14.

[7] *Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin*, March 1917, No. 57, p. 27.

Aton-cult. That there are no traces whatever of such influences, but that the Aton-cult is in every respect essentially Egyptian, the facts set forth in this article must have made perfectly clear. However, it is possible that Ōkhnatōn had foreign blood in his veins, for Prof. Elliot Smith maintains that his maternal grandfather, Iuyu, is distinctly non-Egyptian in type. To this dash of foreign blood, therefore, may well be due the originality clearly displayed by Ōkhnatōn in the particular expression which he gave to a certain trend of religious thought prevailing among his contemporaries.

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Scientific Investigation of the Whaling Problem.

By Sir SIDNEY F. HARMER, K.B.E., F.R.S.

THE Colonial Office has recently announced that the *Discovery* has been purchased by the Crown Agents for the Colonies, on behalf of the Falkland Islands, for employment in researches, principally on whaling, off South Georgia and the South Shetlands. The *Discovery* was built for Capt. R. F. Scott's first Antarctic Expedition (1901–1904). She is a strong wooden vessel of about 700 tons register, and she has been chosen with special reference to her suitability for ice-work.

Subantarctic whaling commenced at the end of 1904, at a time when the industry was regarded as almost obsolete, owing to the exhaustion of the old whaling fields. It increased with so much rapidity that more than 10,000 whales were caught during the season 1911–12. At first concerned almost exclusively with the humpback, the operations are at present supported almost entirely at the expense of the much larger fin whale and blue whale. Humpbacks showed an alarming decline in numbers after the 1911–12 season, though they have made some recovery during the last two whaling seasons.

It should be realised that modern whaling is carried on by comparatively small steam vessels fitted with appliances for the capture of the whales, the products of which are worked up by factories on shore or by larger steamers, the floating factories. In either case, suitable harbours are required as bases, and the most favourable localities at present known are South Georgia, which lies to the east of the Falkland Islands, and the South Shetlands, which are farther to the south-west. These islands are dependencies of the Falkland Islands, and are accordingly under British jurisdiction.

As the result of several memoranda which were prepared in 1917 by Mr. E. R. Darnley, of the Colonial Office, an Interdepartmental Committee on research and development in the dependencies of the Falkland Islands was appointed by the Secretary of State for the Colonies in 1918; and its report (Cmd. 657) was published in 1920. The report contained a number of recommendations with regard to the investigations which were required; and the purchase of the *Discovery* is the first practical result of these suggestions. It should be mentioned that an earlier Anglo-Swedish scheme for the investigation of the same problems was abandoned on the outbreak of war in 1914.

The object of the projected voyages is to obtain scientific evidence bearing on the whaling problem generally, with the view of ascertaining to what extent protective measures are required. It has to be determined, in the first instance, what are the species of whales which are being hunted. Although known to the whalers as humpback, fin whale, and blue whale, it is uncertain whether these are identical with the northern whales known by the same names. Whales are migratory animals, and there can be no reasonable doubt that they visit the Antarctic Ocean in order to profit by the rich food-supply of its waters, and that they afterwards depart, fatter than when they arrived, to warmer waters, which are probably visited for breeding purposes. More definite information is required with regard to these migrations, and it is hoped that it may be possible to obtain direct evidence by a system of marking individual whales.

The period of gestation, the seasons when pairing and birth take place, and the rate of growth after birth all need further study. The plankton requires investigation, in view of the dependence of the whales on it for food; while the temperature of the water, with other hydrographical questions, has to be studied, in order to ascertain how far these factors influence the movements of whales. There is already some reason to suppose that the position of the northern edge of the Antarctic ice is a factor which is correlated with the success or failure of a season's working. If the summer is relatively warm the ice will be too far to the south and the whales will probably be too distant from the base. If the summer is cold the whales will be too much to the north. It may be anticipated that there is an optimum position for the ice which brings the main stream of whales to the neighbourhood of the whaling stations.

Although whalebone whales all feed on plankton, individual species are known to have a preference for one kind of plankton rather than another. In most localities the humpback consumes a considerable amount of fish, while the blue whale is said to feed exclusively on Crustacea. The distribution and the seasonal occurrence of various kinds of plankton, and the examination of the stomach-contents of whales, are matters with which the expedition will certainly have to deal; and the results may prove to have a

distinct bearing on the question why each species of whale differs from the others in its seasonal occurrence. The abundance of whale-food is dependent on conditions favourable for the growth of diatoms and other chlorophyll-containing organisms; and in this connexion may be mentioned Mr. A. G. Bennett's interesting observation that the skin of certain whales is covered by a film composed of innumerable diatoms. The evidence is in favour of the view that this skin-film is not present on thin individuals which have recently come down from the north, but that it develops during the stay of the whales in Antarctic waters. The study of the film and perhaps of whale-parasites may prove to be capable of giving important information with regard to migrations.

For many years the Norwegians have taken the leading place in the whaling industry, and they have large interests in Antarctic whaling. It is thus natural that they should feel anxiety with regard to the possible results of a protective policy, and this is shown by an article recently published in the *Anglo-Norwegian Trade Journal* (Vol. 9, No. 98, February). The comments in question were a rejoinder to criticisms of the whaling industry which had appeared in the *Morning Post*, based on a lecture given by myself, as reported in NATURE (Vol. 110, December 16, 1922, p. 827). I had pointed out, on the incontrovertible evidence of history, that the operations of whalers in the past have been invariably followed by a depletion of the whaling fields. The Atlantic right whale no longer frequents the Bay of Biscay in numbers sufficient to maintain a whaling industry, nor is the Greenland whale still common in the bays of Spitsbergen, in Davis Straits, or even in the North Pacific. The grey whale disappeared long ago from the lagoons of California, and there is no longer occupation for the hundreds of vessels which left European and American ports annually, in the eighteenth and part of the nineteenth centuries, in pursuit of the Greenland and other right whales and the sperm whale. With these facts in view the least that is required is the adoption of a cautious policy, lest the mistakes of the past should be repeated.

The whaling companies are admittedly interested in the avoidance of extermination, which would mean the closing of their operations, but their advocates have maintained that, in view of the enormous extent of the oceans which are frequented by whales, the activity of hunters in a small area is not likely to produce much effect in reducing their number. It will be seen, however, by consulting a map, that South Georgia and the South Shetlands lie in the region where the Antarctic Ocean is narrowest, and that they are admirably situated to intercept the stream of whales in their circumpolar movements. It would not be surprising if operations at these stations alone were found capable of depleting very seriously the entire stock of Antarctic whales, even if no new stations were to be founded in other localities, as seems likely to happen in Ross Sea, for example. The danger is all the greater, taking into consideration the highly efficient methods of modern whaling.

The acquisition of a sound body of scientific evidence is the object of the expeditions which are being planned by the Colonial Office. Although I do not conceal my personal conviction, as at present informed, that whaling is being conducted on too large a scale, I do not deny that a study of the subject by competent investigators on the spot may lead to a different conclusion. The Trustees of the British Museum have acted in an advisory capacity to the Colonial Office since they first became interested in Antarctic whaling, not long after its inception. I am authorised to state that they do not desire to take up an extreme position in the matter, but that their efforts are directed to the restriction of whaling to an extent which is not inconsistent with the permanent preservation of whales. This is a moderate view, with which it may be hoped that the representatives of the whaling industry will agree in principle. The article to which I have referred virtually admits as much, and the willing co-operation of the whaling companies will be of the greatest value to the expedition. It may be hoped that it will be possible to find a *modus vivendi* satisfactory to both parties, who are equally interested in preventing the extermination of whales.

Einstein and the Recent Eclipse.

THE results of the expeditions from Canada and the Lick Observatory to Wallal, Western Australia, for the solar eclipse of last September have now come to hand; and both report in favour of the Einstein shift of starlight. In each case the number of stars measured was very large—exceeding eighty—the magnitudes being between the seventh and the tenth. From this it is evident that the exposures were comparatively long, and consequently there would be considerable extension of the corona on the plates, which would obliterate the stars nearest the sun. The measures, however, were sufficiently exact to give a decisive result using the more distant stars. Profs. Campbell and Trumpler measured all their plates in duplicate; the values for the shift at the limb of the sun deduced from the individual plates ranged from 1·59″ to 1·86″, the mean of all being 1·74″, which is only 0·01″ less than Einstein's predicted value.

As Prof. Campbell is well known to have been in no sense predisposed in favour of Einstein's theory, this result, combined with that of Prof. Chant and the mean of the Principe and Sobral results in the 1919 eclipse, will probably be regarded as setting the question at rest. Prof. Campbell says in his telegram that he considers further work of this kind unnecessary, so that he will attack other problems in the Californian eclipse of next September. There are still the plates taken by the Australian expeditions to be measured. This is to be done at Greenwich; their scale is smaller than that of the Lick Observatory plates, so that probably less weight will attach to them.

The evidence as regards the presence of the shift in the solar spectral lines is now fairly evenly balanced "For" and "Against"; but in any case this test is a less decisive one than the other two, since there are so many known causes of shift of spectral lines, which it is not easy to eliminate completely.

A. C. D. C.

Current Topics and Events.

THE agricultural Tribunal of Investigation appointed by the Government to inquire into the present position of the farming industry and to suggest methods for its improvement has issued an interim report. Its recommendations are being actively discussed in the daily press, mainly from the political aspect. At present the majority of farmers are undoubtedly in an unsound economic condition, and especial interest therefore centres in these sections of the report dealing with agricultural organisation and education. The Tribunal is impressed by the extent of co-operative measures both in Europe and in America, and in urging that British farmers should form similar organisations, suggests that the study of the economic organisation of the industry should have fuller recognition in the farm institutes and agricultural colleges. The Tribunal pays a tribute to the work carried out by the research staffs of these institutions and considers that the departments dealing with the economic problem should be further developed. New systems of farm management, in particular the maintenance of livestock on arable land,—the soiling system,—are suggested as urgent problems to be investigated from this point of view. It is pointed out that in the United States 50 per cent. of the research grants are devoted to farm economics as against 10 per cent. in this country. In this connexion, however, it should be remembered that the term "farm economics" has a much wider interpretation in America than would be admitted here, due in part to the absence, until recently, of the settled rural population that marks the older countries. Making due allowance, however, for this and for the characteristic American tendency towards over-organisation, the comment of the Tribunal still remains true in substance. It is to be hoped that this essential bridge between the research workers and the farmers will be strengthened as a result of the Tribunal's recommendations.

THE Secretary of State for the Colonies has appointed an executive committee to control the researches recommended by the Inter-Departmental Committee on Research and Development in the Dependencies of the Falkland Islands, and in particular the investigation of the question of the preservation of whales and of the whaling industry, which has been subject to Government regulation since its inception nearly twenty years ago. The members of the committee are as follows:—Mr. Rowland Darnley (chairman), Colonial Office; Sir Sidney Harmer (vice-chairman), British Museum (Natural History); Mr. H. T. Allen, Colonial Office; Mr. J. O. Borley, Ministry of Agriculture and Fisheries; Capt. R. W. Glennie, R.N., Admiralty; Mr. J. M. Wordie, Royal Geographical Society; and Sir Fortescue Flannery, of Messrs. Flannery, Baggallay and Johnson, consulting naval architects to the Crown Agents for the Colonies, who has consented to serve as a member of the committee until the *Discovery*, which has been purchased for the purposes of the research expedition, has been reconditioned. In another part of this issue, Sir Sidney Harmer gives some account of the scientific results to be expected from the cruises which it is anticipated the *Discovery* will undertake.

THE report of the nineteenth year's work of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington has lately been issued in the Year Book of the Institution for 1922. The non-magnetic ship *Carnegie*, after twelve years' voyages which have been of great import to the science, is now out of commission for a time, while the observing staff is largely occupied with re-observations in land areas where further information, chiefly to determine the secular variation, was needed. An analysis of the vast body of data acquired by the Department is now in progress. Two magnetic observatories have been set up, in Western Australia and in Peru, regions of the globe where such institutions are much needed, and help has been given in carrying on the former German observatory at Apia, in Samoa. The Department has now turned its energies to the much-neglected study of earth-currents, and is devising new methods of registration. Dr. S. J. Barnett, chief of the section of experimental work in pure magnetism, is vigorously prosecuting his researches on magnetism by rotation, and the converse effect. The investigation of atmospheric electricity is also being extended. A conference of American men of science was held at the Department during the year, in order to consider what modifications, if any, of the original programme of the Department should now be made, and the conclusions and recommendations of the conference are being taken as a guide in the further development of the activities of the Department.

IN the "Shirley Institute Memoirs," vol. 1, 1922, recently received, are collected the ten papers published during the year by the British Cotton Industry Research Association. A perusal of this volume affords an encouraging picture of the future of textile research in this country if the high standard indicated is maintained. The work described falls naturally into three well-defined sections—chemical and physical, biological, and technological. Four papers are résumés of the literature of some chemical, physical, and botanical aspects of cotton, and should be of much value to workers in this field, in which the literature is scattered and much of it almost inaccessible: more than 380 references are given. The biological papers have been dealt with previously in these columns and need no further mention. The three most striking papers are the technological contributions dealing with some properties of yarns, such as regularity in relation to tensile strength and twist. They materially increase our somewhat scanty knowledge of the nature of yarns, and the original methods of investigation described are of wide application. Until the present publication little of permanent value has been done on yarn structure since the pioneer work of

Oliver in 1905–7 (Proc. Roy. Soc. Edin.). A large field of work of extreme difficulty and fascination is here awaiting attack by the physicist and the mathematician, and not the least important of the functions of textile research associations lies in removing such problems from the almost complete obscurity and isolation they have hitherto "enjoyed." It is almost unknown outside the industry that many of the most fundamental problems in textile technology are problems for the mathematician and the mathematical physicist, and there is little doubt that in a few years' time a real and considerable demand will exist in the textile industries for such workers: this should not be without interest for those engaged in the training of students in our universities.

THE Ministry of Agriculture and Fisheries has reissued Leaflet No. 71, dealing with the Colorado beetle. The discovery of this destructive insect in the neighbourhood of Bordeaux last year renders it necessary to take any precautions possible in order to guard against its entry into this country. On several occasions it has been carried by shipping to Europe, and has even become temporarily established on a small scale. During 1901–02 it occurred in potato plots in the neighbourhood of Tilbury docks, but was successfully eradicated by prompt measures. The present infestation in France is of a most serious nature, and it is known to have spread over about 100 square miles. In all probability its area of occupation is even larger, as it is difficult to investigate so large a district with equal thoroughness. The reappearance of the insect during the coming season will be watched with some anxiety, and, unless the most drastic measures are taken on a very large scale, there is every chance that it will remain, and ultimately establish itself as a continental pest. In the latter event it can be scarcely more than a matter of time before it reaches England, since it is obviously impossible to prevent stray insects coming over unobserved in vessels from Bordeaux. The potato in this country is singularly free from insect pests, and it is to be hoped that the Colorado beetle will be unable to establish a footing. It is, however, gratifying to know that the Ministry of Agriculture has given the matter the fullest consideration; but it is incumbent upon all growers to inform the Ministry of the first sign of the appearance of the insect in the field, in order that it can be dealt with immediately by experts. There is no doubt that it can be eradicated if measures are taken sufficiently early; but it is evident that in France it has spread and multiplied to an extent which renders effective control a matter of great difficulty.

IN the issue for March 9 of *Chemistry and Industry* appears a review of the position of the nitrogen industry in France. The French Chamber of Deputies has recently approved the agreement made in November, 1919, with the Badische Anilin und Soda Fabrik, whereby the French were to pay 5,000,000 francs for the right to work the Haber process, together with all information necessary to carry on the process as worked at Oppau and Merseburg. Part of this sum would be paid on the ratification of the agreement, and the remainder when the factory has produced a minimum of 20 tons of fixed nitrogen per day for fifteen consecutive days. A royalty would also be paid when production reached a certain figure. The agreement has given rise to much discussion of the merits of the Haber and other processes. An inquiry instituted by the French Government in 1921 led apparently to the conclusion that under existing conditions the Haber and Claude processes offered practically equal advantages, and the matter can be settled only on the basis of experience gained in working the various processes on a large scale over a considerable period. (Cf. NATURE, vol. 107, page 765; vol. 111, page 101.)

SEVERAL new flying records were established during February, according to the *Meteorological Magazine* for March. A record climb of 20,000 feet in 12 min. 24 sec. by Flight-Lieutenant Haig at Martlesham Heath is noted as announced in the *Times* of February 6. The speed at ground level was 189 miles per hour. At Marseilles, on February 15, M. Sadi Lecointe is said to have broken the world's record for speed over a four-kilometre course: his average speed was 234⅔ miles per hour, breaking the previous record by more than 10 miles per hour. Another French airman, M. Maneyrol, on February 26 established a record, making a motorless flight of 10 kilometres (horizontal distance) near Cherbourg during a strong south-westerly wind. Three notable flights are said to take place this year: an expedition of five French aeroplanes was to start on March 15 on a world tour, probably lasting two years. An American crew will fly from Berlin to Chicago, towards the end of the year, in the Zeppelin air-cruiser now being constructed for the American Government. A flight across the North Pole is to be attempted at the end of June in connexion with Amundsen's expedition; the distance to be covered is 2250 miles, and it is expected to fly this distance from Point Barrow to Spitsbergen in 26 hours.

WE are asked to announce that the Museum of Practical Geology, 28 Jermyn Street, S.W.1, is closed for repairs until further notice. The offices and library of the Geological Survey remain open.

THE Brussels correspondent of the *Times* states that it has been decided to begin Summer Time in Belgium on April 21.

ON Thursday next, April 26, at 3 o'clock, Prof. J. T. MacGregor-Morris will begin a course of three lectures at the Royal Institution on "Modern Electric Lamps," and on Saturday, April 28, Dr. Leonard Williams will deliver the first of two lectures on the "Physical and Physiological Foundations of Character." The Friday evening discourse on April 27 will be delivered by Prof. C. V. Boys on "Measurement of the Heating Value of Gas," and on May 4 by Prof. Soddy on the "Origins of the Conception of Isotopes."

AT a quarterly meeting of the council of the Royal College of Surgeons of England, held on April 12, the

Jacksonian Prize for the year 1922 on "The effects produced by radium upon living tissues, with special reference to its use in the treatment of malignant diseases," was awarded to Mr. H. Sidney Forsdike, of the Soho Hospital for Women. Sir Arthur Keith was elected Vicary lecturer for the ensuing year.

DR. H. H. DALE, head of the department of biochemistry and pharmacology of the Medical Research Council, the Rev. G. Milligan, Regius professor of divinity and Biblical criticism in the University of Glasgow, and the Very Rev. Dr. W. F. Norris, Dean of York, have been elected members of the Athenæum Club under the provisions of the rule of the club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

THE Institute of Physics admits physicists to a grade of associate membership, and it is believed that there must be a large number of young physicists at present outside the Institute who are eligible for this grade. All students and others who have conducted a year's work of satisfactory research are eligible if they have a degree of approved honours standing, or if they pass the equivalent examination of the Institute. Ultimately, it is probable that the associate group will be much larger than that of fellowship, and that new fellows will be selected mainly from it. The Institute has now an appointments register, and many applications for young physicists have been received from manufacturing firms and research laboratories. Regulations for admission to the Institute can be obtained from the secretary, Mr. F. S. Spiers, 10 Essex Street, Strand, London, W.C.2.

AT the meeting of the Royal Geographical Society held on April 9 the president announced that H.M. the King had been pleased to approve the award of the Royal Medals as follows: The Founder's Medal to Mr. Knud Rasmussen for his exploration and research in the Arctic regions during the last twenty-five years; the Patron's Medal to the Hon. Miles Staniforth Cater Smith for his explorations in the unknown interior of Papua. The council has awarded the Murchison Grant to Capt. A. G. Stigand for his map of Ngamiland; the Back Grant to Mr. B. Glanvill Corney for his studies in the historical geography of the Pacific; the Cuthbert Peek Grant to Messrs. R. A. Frazer and N. E. Odell to assist them in continuing their explorations of Spitsbergen; and the Gill Memorial to Capt. Augiéras for his journey in 1920–1921 from Algiers to Mauritania.

PRELIMINARY notice has been issued of the arrangements for the Hull congress of the Royal Sanitary Institute to be held on July 30–August 4. An inaugural address will be delivered by the Right Hon. F. R. Ferens on the first day of the meeting; on July 31, Sir Alexander Houston will lecture on "A Pure Water Supply," and a popular lecture on "Industry and National Welfare" will be given by Mr. B. Seebohm Rowntree on August 2. The congress will meet in four sections dealing with sanitary science, engineering and architecture, maternity and child welfare including school hygiene, and personal and domestic hygiene, respectively, and there will be numerous conferences of sanitary inspectors, health visitors, medical officers of health, veterinary inspectors and representatives of sanitary authorities. During the congress, a Health Exhibition will be held in the Wenlock Barracks.

THE annual report of the director of the Field Museum of Natural History, Chicago, for 1921, is written by D. C. Davies, who succeeded the late F. J. V. Skiff on December 19 of that year. The chief event chronicled is the re-opening of the museum in its new building (which is, we believe, in Grant Park) on May 2, 1921. The opportunity has been taken to place on exhibition for the first time a skull of the northern mammoth, found in gold-mining at a depth of 100 feet at Woodchopper Creek, Alaska. The specimen is represented on a Plate. Among accessions is to be noted the collection of Lower Palæozoic fossils made, chiefly from Ohio localities, by the late C. B. Dyer. The bird collection has been enriched by a large number of albinos and specimens of abnormal coloration. The removal of the museum has led to a large increase in the number of visits, especially by school children.

AT the Boston meeting of the American Association for the Advancement of Science in December last, the centenary of the birth of Gregor Mendel and Sir Francis Galton was celebrated by a series of addresses which are published in the March number of the *Scientific Monthly*. Prof. E. M. East dealt with "Mendel and his Contemporaries." Prof. T. H. Morgan, in a paper on "The Bearing of Mendelism on the Origin of Species," points out that small mutations are really the material on which Darwin chiefly relied to furnish a basis for evolution. He also discusses the question of species sterility, and points out difficulties of evolutionary interpretation which may arise from the occurrence of parallel mutations. Dr. J. Arthur Harris compares the influence of Mendel and Galton on the history of biology, and concludes that the latter has had a more varied and far-reaching effect on the history of science. Finally Prof. G. H. Shull asks for donations to a "Galton and Mendel Memorial Fund," the money to be applied to the publication of expensive illustrations in the journal *Genetics*.

WE have received from Messrs. Ridsdale and Co., of Middlesbrough, a report on the second period of three years in the preparation and use of a series of chemical standards prepared by this firm, with the voluntary co-operation of a number of analytical chemists throughout the country. The report was submitted to a meeting of the co-operators held recently at York. Very thin turnings of steel are now being used to facilitate the determination of carbon by combustion. The series of standards now available includes the whole range of carbon steels, together with four alloy steels, two cast irons, and a basic slag. Certain resolutions were passed at the meeting, urging the desirability of extending the use

of chemical standards for analysis, and the establishment of a more formal organisation on a firmer financial basis. These standards are now widely used, and the movement seems likely to become self-supporting, some 15 or 20 co-operators taking part in each standardisation, and the number of users, both at home and abroad, being large.

UNDER the title *Capita Zoologica*, a new quarto Dutch zoological periodical has recently appeared. It is issued under the editorship of Prof. Dr. E. D. van Oort, director of the State Museum of Natural History at Leyden, and is composed of transactions on systematic zoology, each part forming a complete work which is sold separately. A number of transactions will form a volume of about 500 pages, with plates and engravings. The contributions are published in English, French, and German. The part before us of this well-executed publication is Deel 1, Aflevering 4 (1922, price 24 guilders), and is devoted to a description of flies of the group Dolichopodinæ of the Indo-Australasian region by Th. Becker. It is evidently an important contribution by this recognised authority, and extends to nearly 250 pages, 222 illustrations occupying 19 plates. The previous three parts of this journal deal respectively with Nematodes, by Dr. J. G. de Man; Rhizostomes, by Dr. G. Stiasny; and Oligochætes, by Prof. W. Michaelsen.

WE have received from Messrs. Pastorelli and Rapkin, Ltd., of 46 Hatton Garden, E.C.1, a new catalogue of chemical thermometers. All the instruments listed are stated to be of British make, and as a guarantee of this the thermometers bear the name "BRITGLA," the registered trade mark of the British Lampblown Scientific Glassware Manufacturers Association, Ltd. The list in question is very comprehensive and covers a variety of ranges from −30° C. to 600° C. Thermometers with corresponding ranges on the Fahrenheit scale are listed in most cases. The ranges are varied in such a manner that it should be possible to select a reasonably open scale thermometer for any temperature. Quotations are given for two main classes of thermometers, namely, low-priced chemical thermometers and best quality standard laboratory thermometers. We are pleased to note that in both classes there is a considerable reduction in the prices which have been prevailing of late years. For convenience, the cost of supplying National Physical Laboratory certificates with the latter class of instruments is shown separately. A special section is also devoted to high range thermometers constructed of borosilicate glass and nitrogen-filled. These can be supplied in metal sheaths for industrial use.

PART 3 of volume 1 of the Abstract Bulletin of the Research Laboratory of the Lamp Works of the General Electric Co., Cleveland, Ohio, deals with 36 researches recently published, and extends to nearly 220 pages. It has been found advisable to expand the pure and applied sections of the laboratory into two separate laboratories for pure and applied science under the directions of Dr. E. F. Nichols and Mr. M. Luckiesh respectively. Both laboratories contribute to the researches abstracted in the present part. As an illustration of the thorough way in which industry in America is going into the scientific and technical questions which underlie manufacturing processes, we would direct attention to a paper of 32 pages by Mr. Luckiesh on the physical basis of colour technology, in which the methods used to investigate, by the help of the spectro-photometer, the properties of the dry pigments used in the paint industries, of the dyes, their mixtures and solutions, and of the various substances used in producing coloured glasses, are described. With data of the kind described available, many of the difficulties and obscurities of the colour industries are removed, and progress becomes rapid, while without them much groping in the dark is inevitable.

PART F of the "Guide-book of the Western United States" has just been issued as Bulletin 707 of the U.S. Geological Survey. Its author, Marius B. Campbell, writes for the tourist who looks with an intelligent interest from the windows of his parlour-car on the "Denver and Rio Grande Western Route"; but side-excursions are duly encouraged and described, and the maps show, in brown stippling, some ten miles depth of country on either side of the adventurous line. Numerous illustrations are given of the scenery along the route, which starts from Denver and ends at Salt Lake City. West of Canon City (not "Cañon" or "Canyon," be it observed) the railroad enters the Royal Gorge of the Arkansas River, which is cut 1000 ft. sheer in pre-Cambrian granite, overlain by stratified rocks of Upper Cretacous age. We are shown the fantastic arid weathering of the rose-red Permocarboniferous sandstone in the famous Garden of the Gods, and Pike's Peak appears as a portion of a snowy range. The ancient local glaciation of Colorado is not neglected, and the time-honoured error as to the origin of the term *roches moutonnées* is once more repeated on Plate 55. The protected fauna is illustrated, and the fauna that tried in vain to protect itself at the opening of Cainozoic times is finely represented by restorations of Stegosaurus and Triceratops. Stegosaurus, by the bye, means "roofed lizard," not "plated lizard." This and the other guide-books of the series must not be overlooked by those who travel in America, and they contain much geographical and geological information which is rendered accessible in European libraries, through the generosity of the Survey, for those who may never cross the Atlantic.

BULLETIN No. 133 of the Engineering Experiment Station of the University of Illinois is entitled "A Study of Explosions of Gaseous Mixtures," by Prof. A. P. Kratz and Mr. C. Z. Rosencrans. The report contains a valuable bibliography of the subject, beginning with Dalton and Humphry (not "Humphrey" as in the report) Davy, and after passing in review such classical researches as those of Dixon, Berthelot, Petavel, Bone, Jouguet (not "Jouget," as in the report), Thornton, and others, the literature references are carried up to 1921. A brief summary

of this work, and some new experiments by the authors are given. The report will prove useful to all who are interested in this very important subject.

MESSRS. DULAU AND CO., LTD., 34 Margaret Street, W.1, have just issued a valuable catalogue (No. 100) of upwards of 2600 second-hand science books and serials which they have for disposal. The list is conveniently arranged under the headings—ornithology, entomology, conchology, the lower invertebrates, general zoology, botany, horticulture, agriculture, geology, mineralogy, astronomy, mathematics, engineering, and early medical works. It should interest many readers of NATURE.

AMONG the books shortly to be published by the Oxford University Press is "The Glass Palace Chronicle of the Kings of Burma," which has been translated for the Burma Research Society by Pe Maung Tin and G. A. Luce. The chronicle is the work of the committee of "learned monks, learned brahmans, and learned ministers" appointed in 1829 for the purpose by King Bagyidaw of Burma. The title is taken from the Palace of Glass, in a chamber of which the compilation was made.

Our Astronomical Column.

GREECE ADOPTS THE GREGORIAN CALENDAR.—The Gregorian Calendar was adopted for civil purposes in Greece from the beginning of March. As Russia has apparently taken the same step, the old or Julian style becomes practically obsolete. M. D. Eginitis, director of the Athens Observatory, contributes a paper to the *Comptes rendus* of the Paris Academy of Sciences, March 12, in which he notes that the finding of the decree of Nicæa, A.D. 325, shows that, far from prohibiting such a change, it in reality rather demands it. The decree simply directed that Easter should everywhere be kept on the same day; by implication this day was the first Sunday after the 14th day of the first lunation after the spring equinox, which was assumed to occur on March 21. When it was found that the Julian Calendar did not maintain the equinox at this date, the reform at once became appropriate. The causes that for so long retarded its acceptance in eastern Europe were largely removed by the War, and M. Eginitis addressed a memorandum to the Greek Government in December 1918, which has now been followed.

The Greek Church is not at present adopting the reform, the reason being the expectation of the speedy adoption of other calendar changes in the west, for which it prefers to wait.

Some of these reforms are being discussed by the International Congress of Chambers of Commerce now meeting in Rome; but experience shows the extreme difficulty of persuading the world to adopt changes in their fixed habits, however desirable in themselves, so that we can scarcely share the sanguine view of M. Eginitis, who shares the expectations just mentioned.

THE EIGHTH SATELLITE OF JUPITER.—Prof. E. W. Brown contributes an article on this satellite to *Astronom. Journ.* No. 817. He makes use of Delaunay's algebraical expressions for the various terms, which are theoretically available for any satellite; however, in cases of such large eccentricity and inclination as those of J. VIII the terms do not converge rapidly enough to be used straight away. Prof. Brown, whose great experience gained in his new lunar theory comes useful, shows how estimates may be made of the remainders, and in particular finds a solution for the mean motion of the perijove. The general rule both with planets and satellites is that the apse moves in the same direction as the body, but in the case of J. VIII the higher terms of the series reverse the earlier ones, and produce motion in the opposite direction. Prof. Brown refers in his work to G. W. Hill's paper on the motion of the lunar perigee; it is interesting to recall that it was this work of Hill's that gave Brown the idea that he afterwards followed so successfully in his lunar theory.

The period of revolution of the perijove of J. VIII is about 800 years, an unusually long period for a satellite. It is welcome news that Prof. Brown proposes to continue his work till he has arrived at expressions which will enable the place of the satellite to be predicted without the tedious method of mechanical quadratures. Mr. J. Jackson has also been at work on the satellite, using a combination of observed and calculated positions, and gives an ephemeris for the present apparition in the *Observatory* for March. The chief importance of observing this satellite and the still fainter J. IX is that they will ultimately give a better value of Jupiter's mass than any other method.

ASTRONOMY IN THE UNITED STATES.—The section of Year Book, No. 21, of the Carnegie Institution of Washington, dealing with astronomical work carried out in departments of the Institution includes several items of general interest. The so-called K-term in radial velocities, that is, an average motion of recession shown by all spectral types, but especially by type B, where it amounts to 4 km./sec., is discussed. More than half of this is removed by adopting newly determined wave-lengths for the lines of oxygen, nitrogen, silicon and helium that were used; it is further pointed out that certain lines formerly used were double, and therefore unsuitable. A small residual recession may be due to the Einstein effect. Work on the proper motions of the red stars has shown that these are generally small in the case of types M and N; M stars have large radial velocities, they are therefore mainly giants, and very distant. The radial velocities of type N stars are small, indicating that their average mass is high. Both types give much the same direction for solar motion as that generally adopted.

Studies have also been made on the progressive differences of spectra from type Bo to B8. In B8 the oxygen and nitrogen lines disappear, while a number of enhanced metallic lines appear; it is anticipated that discussion of these facts may advance the theory of ionisation, and our knowledge of the constitution of matter.

The meridian observers seem to be worked very hard; they are on duty for a week at a time, and observe time-stars at intervals not exceeding 6 hours, besides circumpolars at both culminations. What would the advocates of an 8-hour day say to this? The object is to eliminate personality, but it is found that when an observer is fatigued he observes differently than he does when fresh. One of the objects of this series of observations is to determine the laws of differential refraction both in Right Ascension and Declination, and if possible to connect it with the meteorological conditions. There is little doubt that differential refraction is the cause of the perplexing variations in time-determinations from different observatories, and that its determination would mean a marked increase of accuracy in meridian work.

Research Items.

BONE HARPOONS DISCOVERED IN YORKSHIRE.—In 1922 Mr. A. Leslie Armstrong described in *Man* two bone harpoons said to have been found at Hornsea, West Yorkshire. At the Hull meeting of the British Association the harpoons were again exhibited, and Mr. Sheppard, curator of the Hull Museum, questioned their authenticity on various grounds. The matter having been brought to the notice of the Council of the Royal Anthropological Institute, a committee, consisting of Sir C. H. Read, Dr. A. Smith Woodward, and Prof. Percy F. Kendall, was appointed to investigate the matter. The report of the committee is published in the April issue of *Man*. The members report that there is no evidence in the objects themselves that is conclusively against their genuineness: that the similarity of the barbs in the two examples, though found 4 miles apart, points to the conclusion that they are the work of the same individual. "It is worthy of remark that at the time the earlier find was made there was no available example of a Maglemose harpoon." "Mr. Sheppard appears to have had strong grounds for doubting the authenticity of the harpoons, but the evidence on which his judgment is based is no longer verifiable."

BABY CLINIC STATISTICS.—No. X. of the "Studies in National Deterioration" (Cambridge University Press, 15*s*.), forming a subsection of the series of Drapers' Company Research Memoirs, is a thorough analysis of data provided by a baby-clinic in a large manufacturing town, carried out by Miss M. N. Karn and Prof. Karl Pearson. The authors have made very full use of the method of correlation and reach various conclusions of interest and practical importance. Two of these may be noted. The first is that there is a considerable if not very large (0·37–0·43) correlation between the health of an infant at birth and at the end of the first year, a result compatible with general biological considerations, incompatible with the catch word "all babies are born healthy." The second is that although the use of a baby "comforter" is associated with ill health over the full period of observation, the correlation is almost doubled when the health of babies under 14 days old is correlated with use of a comforter. The most plausible interpretation is that the delicate babies are preferentially supplied with comforters rather than that the comforter itself is an important cause of ill health. Those readers who are not versed in the correlational calculus will find the numerous diagrams helpful.

BOTANY IN INDIA.—The report for 1921–22 of Lieut.-Col. A. T. Gage, the director of the Botanical Survey of India, directs special attention to the appearance of Parts I. and II. of the "Botany of Bihar and Orissa," by Mr. H. H. Haines. These two parts contain the description of 76 families, from the Ranunculaceæ to Cornaceæ. Part IV. of the "Flora of the Presidency of Madras," by Mr. J. S. Gamble, has also appeared, containing the families Rubiaceæ to Ebenaceæ. The most interesting economic development in progress appears to be the promotion of cinchona planting in Southern Burma under the superintendence of Mr. P. T. Russell. Cinchona seedlings were planted out in May 1921, on a site near the Heinze river at an elevation of 1700 feet. Unfortunately this situation proved to be apparently "the point of impact of the very arrow head of the monsoon"; during June, July and August more than 240 inches of rain fell and more than half the seedlings succumbed. The survivors have since been growing very well, but it is proposed to recommence operations farther south in the Tenasserim Division of Burma, where the rainfall is both less in amount and more evenly distributed over the year. The cultivation of Ipecacuanha has apparently commenced very successfully on an experimental scale in Southern Burma, the temperature being more equable in this climate than in the Eastern Himalayas where this plant is grown.

GENETICS AND THE HISTORY OF WHEAT.—The Maine Agricultural Experiment Station continues to be prolific in genetic results, the chief contribution being from Drs. Karl Sax and John W. Gowen. In an important paper on sterility in wheat hybrids (*Genetics*, vol. 7, p. 513), Dr. Sax continues his work, in which it is shown that the three groups of wheat species, namely, the Einkorn, Emmer, and Vulgare groups, have respectively 7, 14, and 21 chromosomes as their haploid numbers. He has now investigated the chromosome behaviour in various hybrids between these different groups and finds conditions very similar to those obtained by Rosenberg, Gates, and others in similar hybrids. In crosses between members of the first two groups there are, for example, 7 bivalent and 7 single chromosomes, the latter separating at random when the former split. The origin of the tetraploid and hexaploid conditions in wheat is also discussed. Prof. Percival has shown that all three of the groups of wheat can be traced back to prehistoric times, Einkorn being grown in Central Europe in Neolithic times, Emmer and Vulgare also being prehistoric in Europe, and the former dating back to 5400 B.C. in Egypt. All the groups are therefore of sufficient age for a considerable evolution to have taken place within them. The higher numbers of chromosomes appear to have arisen by duplication of the original set of 7 pairs. This would mean also duplicating the hereditary factors present. Now in wheat, 14 different characters are known to be dependent on one factor, 4 depend on two factors, while only the red grain colour is represented by three independent factors. Hence it would appear that in the polyploid wheats most of these factors had arisen as mutations after the origin of the tetraploid and hexaploid conditions. Prof. Percival considers that the Vulgare (hexaploid) group arose as a hybrid between *Triticum aegilops* and a member of the Emmer (tetraploid) group. The study of the chromosomes is clearly of the greatest importance in tracing the history of our cultivated crops. The species of Avena (oats) show a similar series of chromosome numbers. Polyploid wheat hybrids produce small or wrinkled seeds. The endosperm in a cross between tetraploid and hexaploid forms may contain $14\times2+21(=49)$ chromosomes or $21\times2+14(=56)$ chromosomes according to which is the male parent, as the female parent contributes two nuclei. These unbalanced conditions result in abnormal development of endosperm.

INFECTION AND CYTOLOGICAL STUDIES OF PLASMOPARA.—In the Journal of the College of Agriculture, Hokkaido University, Sapporo, Japan, Vol. XI., Part 3, Makoto Nishimura gives a description of the methods of infection and of fertilisation of *Plasmopara Halstedii* Farlow, parasitic upon *Helianthus annuus* and other Composites in America. Although published in Japan this work was carried out at Columbia University under the guidance of Prof. R. A. Harper. The most striking feature of the infection experiments is the demonstration of zoospore infection through the roots, the zoospores apparently penetrating the middle lamellæ in the absorptive region of the root.

Oospores were freely formed by the fungus, especially in the roots of the host, but also in stem and leaf, and fertilisation was studied in properly fixed and microtomed material. An interesting description is given of a large "receptive pupilla" of the oosphere which protrudes into the antheridial cell at first, in a manner that recalls Murphy's description of fertilisation in *Pythium erythroseptica*. Afterwards this protrusion is withdrawn and apparently its retraction conducts the fertilisation tube from the antheridium into the centre of the oosphere. One nucleus is discharged through this tube into the oosphere from the antheridium.

UNITED STATES GEODETIC SURVEY.—The annual report of the United States Coast and Geodetic Survey for 1922 contains a long record of work accomplished during the year. Hydrographic surveys were carried out principally in the approaches to Chesapeake Bay, off northern California, in the waters of south-east Alaska, and the Philippine Islands. New charts, to the number of 27, were published to cover all areas for which adequate data were available. In some areas, principally Alaskan waters, the production of new charts is delayed until the primary triangulation is completed. The aerial survey of the Mississippi delta was finished and promises such favourable results that an extension of this means of coastal survey is projected. Outstanding features of the geodetic work of the Survey were the completion of the 1600-mile arc from Huntsville in Alabama to Williams in Arizona by way of Memphis and Albuquerque. This arc furnishes accurate positions in seven states and crosses an area badly in need of horizontal control. Work was continued on several other arcs, including one from Dixon Entrance to White Pass, Alaska, which is part of a long arc from Puget Sound, in which the Canadian Geodetic Survey is co-operating. Good progress was made in precise triangulation in Alaska. The Survey is co-operating with a committee of scientific workers in making an intensive study of earthquake phenomena. Magnetic work and tidal observations were extended during the year. The director points out the need for investigations on the Atlantic coast and particularly for the exploration of the Gulf Stream. He urges also that oceanographical work should be undertaken in the Atlantic outside the 100-fathom line and in the Pacific beyond the 1000-fathom contour. Lastly, he emphasises the amount of wire-drag work that must be done along the coasts in the interests of navigation.

THE CRUMPLING AND RIFTING OF EARTH-BLOCKS.—Otto Baschin, of Berlin, in *Die Naturwissenschaften* for February 9, directs attention to what he believes to be a hitherto unnoticed factor in the tectonics of the earth's crust. He starts by the admission of considerable vertical movements of elevation and subsidence in the crust, and these are probably of an order that Wegener's hypothesis rejects. Baschin urges that a rising earth-block, as it comes into a region with greater rotational velocity than that in which it previously lay, becomes a retarding influence in its new surroundings, and in consequence exerts a pressure towards the west. Similarly, a sinking block is an accelerating factor and exerts a pressure to the east. If a continental block sinks on the east side of a line running north and south, and rises on the west, rifting may occur along the line; if it rises on the east and sinks on the west, compression and axial folding are set up. Other cases are of course considered, and the drifting of blocks towards the equator (*Polflucht*) is discussed.

THE LARAMIE PROBLEM OF THE ROCKY MOUNTAIN.—The coal-bearing beds of the Rocky Mountain region have now been the subject of a considerable literature, and in Professional Paper 130 of the U.S. Geological Survey (Washington 1922), F. H. Knowlton presents a useful review of the progress of what is known as the "Laramie problem." In 1875 this problem led Cope to the conclusion that there was no alternative but to assume the possibility "that a Tertiary flora was contemporaneous with a Cretaceous fauna, establishing an uninterrupted succession of life across what is generally regarded as one of the greatest breaks in geologic time." The term Laramie itself arose out of the need for a non-committal term for beds regarded by Clarence King, then at work upon the exploration of the fortieth Parallel, and by F. V. Hayden, busy with the survey of Northern Colorado, as certainly conformable, although it was regarded by King as Tertiary and by Hayden as Cretaceous. Knowlton, having shown that the work of Lee and himself makes clear the existence of an unconformity in the midst of the coal-bearing so-called Laramie rocks of Colorado and New Mexico, points out that when their flora is studied in detail the strata below the unconformity are Cretaceous, and those above Eocene. This work, based upon a long study of all the main collections of plants from these strata, has been in progress since 1889, its publication being delayed until its author was clear that the long-standing problem was definitely in process of settlement. The flora so carefully studied is not in itself extensive, and the preservation of the plant impressions in the soft friable sandstone is far from perfect. The specimens are very fully described, and are figured in 28 plates, some pen drawings, and photographs.

OSAGE OILFIELD, WYOMING.—The Osage Oilfield, Weston County, Wyoming, was developed as the result of the chance striking of oil on land adjacent to the Chicago, Burlington, and Quincy Railroad in 1919, and there sprang into existence, within a year after this discovery, a town having a population of more than 1500 persons, possessing well-built roads and buildings in addition to the usual field equipment in connexion with the production of petroleum and its products. During the same period more than 200 wells were drilled, pipe-lines were laid, and a refinery with a capacity of 500 barrels of oil per day was established. According to investigations by A. J. Collier, published as a bulletin of the United States Geological Survey (No. 736-D), in 1921 the Osage field had an average daily output of 550 barrels of oil; several gas wells were giving collectively 500,000-1,000,000 cubic feet of gas per day, and some eight or nine *flowing* wells yielded a good supply of water (a characteristic feature of this part of the State). Production of oil was maintained during that year from about 100 good wells. Stratigraphically the rocks belong essentially to the Cretaceous system and are of typical Rocky Mountain region facies. The Colorado group, containing the Newcastle sandstone, is the important series of deposits from the point of view of petroleum production. Structurally the field is related to the Black Hills uplift lying to the N.E., and the general dip of the rocks is to the S.W., at about 5° where normal. Minor corrugations in what is otherwise a simple monoclinal structure determine the presence of local anticlines and of the oil. The oil-pools are formed by moderately porous sandstones (about 19 per cent. average porosity) occurring as lenses within the shale formations, and the oil itself is of a light olive-green colour, low specific gravity, and high petrol content.

Climatic Continentality and Oceanity.

By L. C. W. BONACINA.

NOT much less important among the geographical factors which determine climate than latitude and altitude, is the relative distribution of land and sea, or, in short, continentality *versus* oceanity, and in view of the somewhat large class of students who encounter this aspect of climatology it seems desirable to direct attention to a couple of German maps which have recently appeared indicating the distribution of continentality over the globe as a whole and over Europe in detail (*Petermanns Mitteilungen*, June 1922, R. Spitaler after G. Swobodna).

It is possible to represent the mean or normal temperature of a particular latitude at any time of the year in an equation involving, also, the intensity of insolation and the relative distribution of land and water in the neighbourhood; and therefore it comes about that there is a means of seeing how the temperature of a given point in summer, winter, or the year as a whole, compares, on one hand, with full "continentality" such as would uniformly prevail over a hemisphere covered entirely with land, or, on the other hand, with full "oceanity" such as would characterise an entire water hemisphere. The maps in question are based upon the annual range of air temperature between January and July, but are not quite the same thing as simple maps of equal annual range would be, because the annual range is to some extent affected by differences of latitude which are allowed for in the relationship just referred to. Taking full "continentality" as 100, and full "oceanity" as 0 (zero "continentality"), lines of equal percentage value are drawn across the entire map of the world except the inter-tropical belt, uncertainty for which attaches to the fact that the significance of the seasons is not the same as it is in extra-tropical latitudes.

There is a large area in the interior of North America with 90 per cent. continentality, the Sahara region and much of Western Asia with 100, and a considerable portion of Eastern Asia suffering from a super-continentality amounting to as much as 130. This is explained by the abnormal winter cold of Central Asia, due to a certain type of atmospheric circulation set up over this great land-mass, which results in a local degree of continentality greater than that proper to a uniform land hemisphere. A high degree of continentality also prevails over the land-locked North Polar basin where the ice-covering raises the percentage of the Arctic Ocean to near 100. At the other end of the scale we find 5 per cent. (95 per cent. oceanity) over that part of the North Atlantic between Iceland and Norway, and 0 (full oceanity) over much of the oceanic areas in the Southern Hemisphere, while local regions in the South Pacific and the Southern Ocean, under a special trend of sea and air currents, experience a slight degree of super-oceanity amounting to −5 per cent. on the continentality scale (105 oceanity). In consequence of the circulation of the atmosphere there are regions where continentality trespasses upon the sea, *e.g.* the Yellow Sea and Sea of Okhotsk with 70 per cent., and where oceanity invades the land, *e.g.* England and France with 20 to 45 per cent., values actually lower than that of the land-locked Mediterranean Sea, which averages about 45 per cent.

It is clear, therefore, that these maps show something more than the simple effect of local land and sea influences upon the annual range of temperature, and it would have been instructive to have a cartographical representation of this effect as well, uncomplicated by the effect due to the transference of continental and oceanic conditions beyond their respective domains. If one turns, for example, to the more detailed map of Europe, there is 10 per cent. continentality along the west coasts of Ireland and Scotland, and the 50 per cent. line, marking the boundary between the "continental" and "oceanic" parts of the continent, driven back by the prevailing Atlantic winds to the longitude of eastern Germany except for outliers around Spain, Switzerland and Sweden. Even the neighbourhood of London, the most continental portion of the United Kingdom, has a percentage no higher than 27, and the generally low value, about 25 per cent. for England as a whole with a position fairly well balanced as between land and sea, unmistakably reflects the dominating influence of the prevailing oceanic winds. There can be little doubt, indeed, that if the south-east of England were normally controlled by a stagnant contracyclonic system of circulation allowing more local temperature controls to gain the ascendant, the continentality would rise to near 50 per cent., and to near 75 per cent. if the prevailing winds were continental east winds instead of the actual oceanic west winds. This conclusion is strongly supported by the high degree of continentality, about 70 per cent., which prevails on the east coast of the United States in consequence of the westerly circulation from the interior of the continent.

Instructive as these German maps are, they do no more than touch the fringe of the subject inasmuch as there are other criteria by which thermal continentality may be judged, namely, diurnal range of temperature and the magnitude of irregular deviations from the normal, both of which run roughly, but not exactly, parallel with the seasonal or annual range above considered. It could be shown, for example, that in relation to the inland parts of England the east coast is somewhat more "continental" according to annual range than according to diurnal range of temperature. This is because the short-period range between day and night is more definitely influenced in the long run by local distance from the sea, whereas the seasonal range of temperature is more markedly affected by continental types of weather, transporting summer heat or winter cold, on the east coast than it is farther west.

Interesting, too, is the study of continentality from the point of view of deviations of particular seasons from the normal, and here a striking lesson is afforded by the climates of London and Paris. The French capital on the average of a long series of years is 2° F. colder than the English in January and 3° F. hotter in July, the greater difference in summer being apparently due to the more southerly latitude, which would work with the continentality difference in the warm season but against it in the cold. Yet it is during occasional periods of severe cold that the more violent continentality of Paris is so emphatically demonstrated. The month of December, 1879, was, on the continental mainland, one of unparalleled rigour, the mean temperature day and night for the entire month in Paris being so low as 18° F., or some 20° below the normal. But the coldest December ever recorded in London, that of 1890, a month of appalling gloom and as cold as any winter month that has occurred since the establishment of records, had a mean temperature not lower than 29° F., or only 10° below normal, while the same month in Paris was 12° below, or only less cold than 1879. There are many similar instances of wider departures from the normal on the other side of the Channel.

Facts of this kind constitute an obtrusive aspect of climate, but they are apt to be eclipsed in the common practice of limiting one's studies to means and averages.

Discovery of Marine Beds at the Base of the Gondwana System in Central India.

MOST of the papers recently published in the Records of the Geological Survey of India naturally take the form of shading with details the general outline previously known. Some of the results published in the last general report of the director (Records, Geological Survey of India, vol. 54, Part 1) are, however, of special interest as showing that some of the previously accepted outlines need reconsideration. We have space to notice only one of them at this stage, and that because the director's announcement may not be superseded for some time by a more detailed description.

Among the results hitherto regarded as final has been the conclusion that the Peninsula of India has never been submerged beneath the sea since early Palæozoic times, except for narrow strips extending not far from the present coast lines. Towards the end of 1921, however, the discovery by Mr. K. P. Sinor of a very thin marine bed at the base of the Lower Gondwana system, on the small coalfield at Umaria in the Rewah State of Central India, suggested a review of the previously accepted view regarding the stability of the peninsular *Horst*. Early last year, after this discovery had been reported to the director of the Geological Survey of India, a field collector was deputed to obtain further specimens, and these included, besides Productus, a species of Spiriferina related to and probably identical with *Spiriferina cristata* var. *octoplicata*.

This discovery thus unexpectedly provides evidence of the fact that the sea in Carboniferous times trespassed on to the continent of Gondwanaland farther than was previously suspected; for the Umaria coalfield is some 500 miles from the present west coast, 400 miles from the east coast, and 400 miles from the marine formations which lie away to the north of the crystalline axis of the Himalayan range. In view of the fact that portions of the western States of Central India and the northern parts of the Bombay Presidency were invaded by the sea just before the outflow of the great Deccan trap early in Cretaceous times, one is tempted naturally to regard marine trespass from the west as the most natural line of advance and subsequent retreat; but there is a possibility also that this Productus bed in Rewah records the spread southward of the Permo-Carboniferous sea which left thick masses of Productus limestone in the Punjab, Kashmir, and Tibetan plateau.

The discovery is thus one of very great interest to students of geomorphology; but though doubtless the basal (Talchir) rocks of the Gondwana system will now be searched afresh with renewed hope, the chances of finding further evidence are remote. The coal seams of peninsular India all lie above the Talchirs, and mining operations naturally are not carried below the coal beds for purely scientific objects, while it is only around the edges of the coal basins that narrow strips of the underlying Talchirs occasionally peep out. The surface is fairly flat—a soil-covered peneplain which is lapped over on its northern margin by the mantle of Gangetic alluvium of unknown thickness.

Some years ago this discovery would have had a double interest; for the problem of correlating the great freshwater Gondwana system with the standard stratigraphical scale was the occasion of some controversy due to differences of opinion which naturally follow indirect inferences from homotaxis. But twenty years ago characteristic members of the Lower Gondwana Glossopteris flora were found associated with Productus beds in Kashmir, whither presumably they were carried by one of the rivers then running from Gondwanaland into the great Eurasian ocean known to geomorphologists as Tethys. The base-line thus became definitely established and at a level in the vertical scale near that which W. T. Blanford and others had advocated from indirect evidence many years before. Blanford lived long enough to hear of the Kashmir discovery, which proved that in the Indian region the Productus marine fauna and Glossopteris land flora were contemporaneous. What polemics would have been saved, probably, if he had surveyed the Central Indian instead of the economically more important eastern coalfields, and had thus been able to start from a recognisable stratigraphical base line on the Peninsula itself.

The Calcutta School of Tropical Medicine and Hygiene.

THIS teaching and research institution was opened two years ago, and an account of its work is given in a paper by one of the staff, Major Knowles. The laboratory has four floors with 220 feet of north light and a shorter wing at right angles to the main front, while the special hospital for tropical diseases has more than 100 beds, both having been constructed and partially endowed at a cost of about 120,000*l*., nearly two-thirds of which were raised by the founder, Sir Leonard Rogers, and by Major Knowles. The staff of whole-time professors and research workers now numbers thirty-three, special laboratories and investigators being provided for kala-azar, dysenteries, ankylostomiasis, leprosy (for which a separate institute is to be built opposite the school at a cost of another 20,000*l*.), diabetes and filariasis, all in addition to the teaching staff of the school. The departments now number seventeen, three or four sections commonly combining on one research under the director, Col. J. W. D. Megaw, thus furnishing the team work so essential to success.

The teaching is purely post-graduate, the number admitted being limited to 50 by strict selection. The course for the diploma in hygiene lasts nine months and that in tropical medicine six months, against four in the Liverpool and three in the London School of Tropical Medicine. After an hour's clinical work in the hospital, a lecture is given illustrated by numerous lantern slides, epidiascope pictures, and cinematograph films. This is followed by practical work in the class-rooms for the rest of the day illustrating the same subject, after which that lecturer is free for the rest of the week for research and preparation for his next class.

In the short time the Institution has been open, important work has been published, or is in the press, on the pathology and treatment of leprosy by Muir; on the diagnosis by a new test and the treatment of kala-azar by Napier; on the differentiation of chronic dysenteries by the reactions of the stools by Knowles and Napier; on the poisonous amines of dysentery and cholera bacilli, and also in lathyrism and epidemic dropsy by Acton, Chopra (professor of pharmacology), and S. Ghosh (chemist). Tropical skin diseases are being closely studied with the help of the full-time artist and the photographer of the school. Every case admitted is worked out clinically and microscopically by all the sections concerned, and careful records are kept. This cannot fail in due time to result in important additions to our knowledge of tropical diseases in view of the unrivalled clinical

material available in the special hospital and in the 600 additional beds of the adjacent Medical College group of hospitals.

The new Institution is evidently destined to take a leading place in scientific medical research and teaching in the British Empire.

Virus Diseases of Plants.

HUMAN pathology has naturally had first claim upon the services of the investigator of disease, but a study of plant diseases is probably equally essential to human progress, and the timely review in *Science Progress* (No. 67, January 1923), by Dr. E. J. Butler, director of the Imperial Bureau of Mycology, bears eloquent witness to the great activity with which the special problems of plant pathology are now being attacked. It was only towards the close of the last century that the propagation of disease in plants was shown to be effected in some cases by a filterable virus, but since then facts and theories as to virus transmission have followed in rapid succession from various Continental and American laboratories. Very few observations have so far come from British laboratories, and it may be hoped that the very comprehensive and critical review presented by Dr. Butler will direct more attention to this fascinating field of work.

Many obscure conditions prevailing among growing plants should receive elucidation as a result of investigation into this problem, while the facilities the plant provides for experimental work may enable the whole mechanism of transmission by a virus to be submitted to a very critical analysis. For more than a century it has been known that in certain cases of variegation, if a branch bearing variegated green and white foliage be grafted upon a plant of the same species with normal green foliage, the variegated habit will slowly extend to the branches formerly bearing normal green leaves. This type of "infectious chlorosis" is still of obscure origin, and in this case, as with the curious "peach yellows," investigated in the United States, and in the "spike" disease of the sandalwood tree in India, grafting appears to be the only artificial method of transmission. All these puzzling abnormalities, varying from innocuous variegation to serious diseases such as the "spike" disease, which threaten to extinguish a profitable crop, may receive elucidation through the study of virus diseases more amenable to experimental treatment.

Among the diseases suitable for investigation, perhaps the best known are the "mosaic" diseases, so called from the patchy discoloration they usually produce upon the plant surface. Tobacco mosaic provides a remarkable case of transmission by a highly infectious virus which has been very thoroughly examined by H. A. Allard in the United States. In this case, if the hairs upon an infected plant are carefully cut with a sterile scissors, infection may follow if the hairs upon a healthy plant are then cut with the contaminated scissors. Originally considerable support was given to a theory that the infectious principle in tobacco mosaic was enzymic in nature, but Allard showed that, although ultramicroscopic, the infectious substance could be removed from the expressed plant juice by filters that left the oxidase activity of the juice practically unimpaired. However, the strongest argument in favour of an organism is furnished by dilution experiments in which the expressed juice, diluted to 1 in 10,000, still retains infectious properties. One of the most puzzling properties of the tobacco virus is its extraordinary stability to chemical reagents usually very toxic to living protoplasm and its resistance to relatively high temperatures. In the absence of any information as to the life-history of the invisible parasite it is impossible to correlate this resistance with any special growth form.

The invisibility of the organism sets an upper limit to its size in accordance with the resolving powers of the microscope; experiments with bacterial filters, in view of their tendency to clog, do not permit a lower limit of size to be assigned with confidence, while, on the other hand, the way in which a mycetozoan plasmodium will filter through a cotton-wool plug, cleaning itself from ingested food particles in the process, suggests caution in considering passage through a filter a proof that the natural diameter of the organism is smaller than that of the pore of the filter.

Although a filterable virus was first demonstrated as a cause of disease in the case of the tobacco mosaic, plant pathology is not so far advanced in its study of the organism as human pathology.

One great difficulty is that the culture of the organism outside the plant has so far proved impossible; in this respect these are as confirmed pathogens as the well-known group of rust fungi. Some of the virus diseases, as potato leaf-roll, net necrosis of the tuber, etc., seem to propagate only within a special tissue, the phlœm. This is worthy of consideration when attempts are made to cultivate the organism on artificial media, as the phlœm is relatively alkaline in reaction and both cell walls and contents are probably very distinctive in chemical composition.

Many of these virus diseases are propagated by insects, and Dr. Butler discusses critically the evidence which has been brought forward to explain the greater success of transmission when the plant cuticle is pierced by the insect rather than by needle or knife. One interesting possibility is the need for a necessary part of the life cycle of the pathogen to be completed in the insect carrier, but more work is also required upon the natural healing of punctures caused by insects and by instruments. The manner in which some aphids are also alleged to puncture always in the neighbourhood of the phlœm also provides a very interesting problem for further observation and experiment.

One interesting result of this work is the considerable significance it gives to the aphis as a carrier of plant diseases. At the International Potato Conference held under the auspices of the Royal Horticultural Society in November 1921, Mr. A. D. Cotton pointed out how the recent work of Quanjer in Holland and Schultz and Folsom in the States emphasised the importance of the relative intensity of aphides and possibly other insects in the propagation of leaf-roll. This disease, which is of very great economic importance, seems to spread from plant to plant chiefly in districts where the aphis-attack is general early in the season. As a result, the disease is transmitted very extensively in the warmer English counties, while in the Northern Scottish counties its spread may be little or nil, coincident apparently with the relative absence or late development of aphis infestation. This is very suggestive in relation to the proved value of Scotch seed-potatoes, and this important problem alone, with the new light it throws upon the principles to follow in seed-selection, would justify the extensive exploitation of this comparatively new field of scientific investigation.

University and Educational Intelligence.

ABERDEEN.—Mr. W. G. Mackinnon has been appointed assistant in geology in succession to Miss Margaret Smith, resigned.

LIVERPOOL.—On March 2 a new building comprising five chemical laboratories was opened by Lord Haldane as an extension of the University. Three floors are devoted to inorganic and two to organic chemistry, with extensive provision for research work. The building forms part of a scheme outlined before the War, which will require a further sum of 175,000*l.* for completion.

LONDON.—The following doctorates have been awarded:—*Ph.D. in Science*: Mr. R. J. Ortlepp, of the London School of Tropical Medicine, for a thesis entitled "Studies on Helminthes Parasitic in Terrestrial Vertebrates," and Miss W. A. Leyshon, an external student, for a thesis entitled "Forced Oscillations in Self-maintained Oscillating Circuits."

A number of free public lectures and courses of lectures by distinguished men of science has been arranged for this term. At University College, Sir Thomas Holland will deliver three lectures on "Phases of Indian Geology"; Prof. G. N. Lewis, professor of chemistry in the University of California, three lectures on "The Structure and Behaviour of the Molecule"; and the following lectures by well-known Dutch scientific workers: "The Electric Charge of Colloids," by Prof. H. R. Kruyt, professor of organic chemistry in the University of Utrecht, on May 8; "The Rotation of the Earth and its Influence on Optical Phenomena," by Prof. H. A. Lorentz, professor of physics in the University of Haarlem, on May 17, in addition to a course of three lectures, commencing June 4, on "Problems in Relativity." Other lectures at University College include three by Mr. W. Macnab on "Some Scientific Principles of Chemical Industry," three by Prof. G. Dawes Hicks on "Kant's Theory of Beauty and Sublimity," one by Prof. C. Spearman on May 25 on "Psychology as a Career," and one by Prof. W. M. Flinders Petrie on May 17 on "Recent Discoveries in Egypt."

At King's College, there is a course of three lectures, on "Ethics and the Philosophy of History," prepared by the late Prof. E. Troeltsch, professor of philosophy in the University of Berlin; and four lectures on the tercentenary of the birth of Blaise Pascal by Prof. H. Wildon Carr.

Other lectures arranged under the auspices of the University are: three lectures by Dr. P. Giles at the School of Oriental Studies on "The Aryans," and a lecture, on May 7, at the Imperial College of Science, by Prof. W. de Sitter, professor of astronomy in the University of Leyden, on "Problems of Fundamental Astronomy."

Notice of the lectures will be given from week to week under the heading "Public Lectures" in NATURE.

IT is stated in the *British Medical Journal* that Dr. J. S. Anderson has been appointed to the chair of medicine at the University of Hong Kong. Dr. Anderson had a distinguished career at the University of Glasgow, and afterwards joined the staff of the Helminthological Department of the London School of Tropical Medicine.

A PRELIMINARY announcement has been issued regarding the University of Geneva Summer School to be held on July 16–September 1. In addition to the usual courses in modern French language and literature and lectures on current international problems (including the projects and achievements of the League of Nations, the International Labour Office, the Red Cross, etc.), there will be, for advanced students only, laboratory and field work in botany under the direction of Prof. Chodat at La Linnea (altitude 5600 feet) in the Mont Blanc district, and field geology and mountain climbing under the direction of Prof. Collet in the Mont Blanc, Jungfrau, and Matterhorn regions. Among the lecturers at the Summer School last year were professors of the Universities of Geneva, Paris, Bonn, Vienna, Christiania, Turin, and Washington, and of Dartmouth College (U.S.A.). Detailed information can be obtained from the Swiss Legation.

PROF. E. W. SCRIPTURE, formerly of Yale University and latterly engaged in carrying out investigations in London, has been appointed honorary professor of experimental phonetics in the University of Vienna. The appointment is significant alike of the growing importance of the subject, of the revival of this University after the devastation caused by the War, and of the movement discernible in the universities of the world as a whole towards such an interpenetration in disregard of international boundaries as was characteristic of the universities of the middle ages. Prof. Scripture was one of the pupils of the Abbé Rousselot, who was a pioneer in a field of knowledge the scientific exploration of which had scarcely been attempted when the Abbé began his researches thirty years ago. Recently it has yielded results of such immediately practical importance that it is receiving greatly increased attention. Prof. Scripture himself claims to have discovered that phonetics provides an efficient means of diagnosing earlier than would otherwise be possible, and thereby giving opportunities for the application of curative treatment to, general paralysis and disseminated sclerosis; also that the study of speech records of epileptics points to a revision of the hitherto accepted theory of the essential nature of this disease.

WE have received from the Universities Bureau of the British Empire a list of students from the King's Dominions Overseas and from foreign countries enrolled for the current session in universities and university colleges of the United Kingdom. It affords material for some interesting statistical comparisons. The total number, 4131, shows a decrease of 8 per cent. compared with the total for the previous session (1921–22). In the following analysis showing the numbers of students from the several continents and countries, the corresponding figures for 1921–22 are given in brackets wherever markedly different: Africa 1171, America 764, Asia 1401 (1576), Europe 542 (645), Australia and New Zealand 250 (280); Egypt 298, including 67 at Birmingham and 81 at London; South Africa and Rhodesia 303, including 82 at Oxford, 43 at Cambridge, 336 at London, 142 (178) at Edinburgh, and 76 (95) at Dublin; Canada and Newfoundland 157 (200), including 60 (87) at Oxford; South America 73; U.S.A. 402, including 224 at Oxford; West Indies and Bermuda 120; China 119 (143); India, Burma, and Ceylon, 1094 (1240), including 175 at Cambridge, 335 (446) at London, 150 (170) at Oxford, 137 (173) at Edinburgh, 101 (65) at Glasgow; Japan 51 (73), France 52, Russia 91, Switzerland 43 (61), other countries of Europe 356 (431). In NATURE, March 3, p. 308, we gave similar statistics regarding students in the United States and in Switzerland.

Societies and Academies.

LONDON.

British Mycological Society, March 17.—A. S. **Horne** and H. S. **Williamson**: The morphological and physiological characteristics of two new species of Eidamia were described and compared with those of *E. acremonioides*, the only species previously included in the genus. One species obtained from oak wood is strongly acidophile and causes coloration of the wood; the other, isolated from decaying apples, is capable of causing rot in Bramley's seedling apple when kept under ordinary storage conditions or at a constant temperature of 1° C.—M. H. **Carré** and A. S. **Horne**: Various fungi were grown in soluble pectin of a high degree of purity extracted from apples. Certain fungi utilise the pectin with production of acidity (Botrytis, *Diplodia cacaoicola*), others break it down completely with the production of sugar (Eidamia from apple), while some are apparently incapable of growth in pectin.—A. S. **Horne** and H. M. **Judd**: The Eidamia from apple grown in sugar solutions exhibits different reactions according to the sugar used, as evidenced by the odour (of coconut oil), liquid coloration, and rate of growth (on plates). The reactions appear to show a definite relation to the configuration of the sugars concerned.—H. S. **Williamson**: The species of Eidamia from oak caused the production of a yellow colour in seasoned wood. This colour was reproduced when normal oak was inoculated with conidia of the fungus, and was found to be partly due to the colour of the conidia and partly to a yellow refractive substance produced in the metabolism of the fungus and accumulated in some of the cells of the wood.—J. S. **Bayliss Elliott** and O. P. **Stansfield**: The life history of *Polythrincium Trifolii*. The Hyphomycete stage is followed by a pycnidial stage. After the pycnidial stage reaches maturity the clover leaves wither. It was found possible to obtain further development by placing the leaves between glass cover-slips placed between ivy leaves buried in soil in plant pots in the open. The perfect form is not a species of Phyllachora as has usually been supposed, but Dothidella.—J. **Ramsbottom**: The correspondence between M. J. Berkeley and C. E. Broome preserved in the National Herbarium covers a period of more than forty years, and gives a clear idea of the way in which the collaboration between the two was carried on. It contains a mass of biographical detail, particularly of Berkeley, and gives a much better picture of the "Father of British Mycology" than do the meagre and misleading biographies which have so far been published.—P. J. **Alexander**: The dates of appearance and habitats of the Mycetozoa of Surrey. No month is without a representative, and three-quarters of the British species have been recorded for the county.

Association of Economic Biologists, March 23.—Prof. E. B. Poulton, president, in the chair.—J. H. **Priestley**: The causal anatomy of the potato tuber. The potato haulm is angular with three leafy expansions rising from the angles; a primary endodermis in the underground stem disappears in the region where the leafy angles appear. The circular, unwinged stem formation is a result of growth in darkness. The formation of the tuber at the end of the stolon coincides with the disappearance of the endodermis and the appearance of cork in the epidermal or subepidermal layer. The increase of tissue in the tuber is due to the meristematic activity both in the cortex and in the periphery of the pith. Earthing up potatoes may increase the stem area from which tuberiferous stolons may arise, and adequate moisture in spring with consequent vigorous root pressure may favour the formation of stolons; tubers may be expected to arise upon the stolons when the evaporation of water from the leaves exceeds water supply from the roots.—E. R. **Speyer** and O. **Owen**: The action of simple aromatic compounds on the cucumber woodlouse (*Armadillidium speyeri*, Jackson). Observations were made on the effects due to contact, vapour, and mixing with the soil at a concentration on M./100 in 250 gm. of soil; *p*-cresol and *p*-nitrophenol are less active than the corresponding ortho compounds, and both nitrophenols are less active than phenol. One part phenol in 750 parts soil is sufficient to kill all woodlice introduced during a period of 20 days, and this time corresponds with the disappearance of retardation in germination of tomato seeds sown in the same soil. Phenol and the cresols were the most active compounds tested; naphthalene disappears within 4 days of mixing with soil; thymol, camphor, hydroquinone, and α-naphthol act slowly.

Royal Microscopical Society (Industrial Applications Section), March 28.—Mr. J. Leonard Spicer in the chair.—S. R. **Wycherley**: Microscopy in the examination of manufactured paper. Paper is composed of disintegrated vegetable fibres, their length, strength, and breadth giving colour and durability. Linen fibres give the strongest and toughest of papers, and in their natural condition are tapered at the ends. The fibres have nodes which often burst, and then the fibres curl over and the hooks entangle one with the other, knitting together. Tested with Herzberg solution the result is brown coloration; with zinc chloride solution, claret coloration. Cotton fibres, the main constituent of high-class writing papers, are even and round with a number of twists along the whole length. Wood fibres are merely fibres of wood crushed or reduced to pulp: chemical wood-pulp fibres are always longer and cleaner than those of mechanical wood pulp. The fibres are distinguished by their bordered pits; they give a low-grade paper. Esparto fibres are long, thin, and smooth with a narrow canal, and there is always a residue of seed hairs. A microscope will often show whether the fibres have been too severely treated by the beaters, and also whether a heavy proportion of re-pulped paper has been used.—J. **Strachan**: The manufacture of papers for wrapping and containing food-stuffs. Legislation is required specifying the proper wrapping for particular foods. Papers for this purpose are classified as follows: Food-holders, such as the paper wrapper and the paper container; food-carriers, such as the box, the carton, and the fibre-board packing-case. The paper bag is used both as holder and carrier. The most important class of paper is that used in direct contact with the food-stuff. The basic paper for this should be a pure bleached cellulose, sterilised during the process of manufacture. Chemical and physical treatment of this base gives a variety of papers for specific purposes, such as the exclusion of colloids, moisture, and gases, or the retention of oily matter and flavours.—H. B. **Wrighton**: Objectives for metallurgy. The mounts should be of a metal which will resist the strongly acid atmosphere present in laboratories where analytical work on metals is carried out, and the front lenses should be protected against damage by accidental contact with metallic specimens. Glasses and cements used must be of a permanent character, as considerable heat is developed by the intense light used in the photomicrography of metal specimens. The most

suitable balance among the various optical corrections differs somewhat from the one generally accepted for the other branches of microscopy; in particular, flare should be reduced to the absolute minimum. The requirements of metallurgical microscopy are sufficiently distinct to justify the production of objectives computed and designed specially for this work.

PARIS.

Academy of Sciences, March 26.—M. G. Bigourdan in the chair.—R. **de Forcrand**: Thallium hydroxide, The usual method of preparing thallium hydroxide by precipitation of the sulphate with baryta is very tedious, and liable to give an impure product. A better method is to treat thallium ethylate, C_2H_5 . OTl, with water and starting with TlOH and Tl_2O prepared in this way, the thermochemical constants have been redetermined.—M. **Soula**: Taylor's series having an infinity of zero coefficients.—P. **Noaillon**: A harmonic function the gradient of which vanishes at infinity.—Henri **Chrétien**: Recording time, in figures, to the thousandth of a second, with an electrically maintained pendulum. A description, with illustrations, of a new recording chronograph of simple construction.—G. E. **Beggs**: The exact solution of problems indeterminate statically by means of paper models.—M. **Lafay**: The possible use of the microphone to facilitate problems of flight.—J. **Trousset**: Can the observation of the planets furnish arguments for or against relativity? The author gives reasons for answering this question in the negative.—Paul **Mondain-Monval**: The variation of heats of solution with temperature. Details of experiments on heats of solution of potassium, sodium, and ammonium nitrates, potassium sulphate, and ammonium and potassium chlorides at 0° and 18° C.—Th. **Tommasina**: Contribution to the dynamo-kinetic theory of the electron and the atom.—Georges **Déjardin**: The critical velocities of the electrons in krypton and the production of the spectra of this gas. An account of work done with a three electrode tube of an improved type. The ionisation potentials of argon and krypton were found to be $15{\cdot}2 \pm 0{\cdot}2$ volts and $12{\cdot}7 \pm 0{\cdot}2$ volts respectively: the double ionisation potentials were 34·0 volts and 28·25 volts. Krypton, like argon, gives two spectra, details of which are given.—Albert **Portevin**: The variations of capacity accompanying the thermal treatment of hollow steel bodies. Study of the influence of the tempering temperature, rate of cooling, and hardness of steel on the changes of capacity of steel shells.—L. J. **Simon** and M. **Fréjacques**: The methylating and sulphonating action of methyl sulphate on phenols in the absence of water. This reaction is very complicated. With phenol at least eight substances are present: methyl ether, anisol, phenol and anisol sulphonic acids and their methyl esters, and methylsulphuric acid. The methods of separation are given.—A. **Mailhe**: A new preparation of the tetrasubstituted ureas. The formamide of methylaniline, C_6H_5 . $N(CH_3)(COH)$, passed as vapour over finely divided nickel at 380°-400° C. gives symmetrical dimethyl-diphenylurea, $CO(N(CH_3)(C_6H_5))_2$. That the method is of general application is proved by other examples.—F. **Bordas** and T. **Touplain**: The denaturation of ethyl alcohol. The use of alcohol as a constituent of a motor fuel requires a cheaper denaturant, and one easily detected. The use of methyl or ethyl borate is suggested.—P. **Gaubert**: The liquid crystals of anisal-*p*-amidoazotoluene. A reply to some criticisms of G. Friedel.—M. **Solignac**: The tectonic of the plain of Mateur and its approaches (Tunis).—F. **Baldet**: Contribution to the study of atmospherics. A method of searching for and partially eliminating low frequency parasitic currents of atmospheric or telluric origin.—Pierre **Dangeard**: The vacuome in the pollen grains of Gymnosperms. Application of the vital coloration method (neutral red) to the study of the pollen grains of *Taxus baccata*, *Cephalotaxus Fortunei*, *Cupressus Lawsonia*, and *Pinus Armandi*.—Mlle. France **Gueylard**: Intervention of the spleen in the phenomena of adaptation to changes in salinity. It is known that *Gasterosteus aculeatus* can be transferred from fresh to salt water, and rapidly adapts itself to the change of medium. It is shown that change in the salinity of the medium results in changes in the spleen, the higher the proportion of salt in the water, the greater the reduction in the proportional weight of the spleen.—Marcel **Duval** and P. **Portier**: The impermeability to urea of certain tissues of selacian fishes.—Jules **Amar**: The law of vivireaction in biology and pathology. This law is stated thus: any pathological or physico-chemical act which tends to reduce the phenomena of organic oxidation provokes, by a defence mechanism, a relative increase of the pulmonary ventilation.—L. M. **Betances**: The specific differentiation of the hematic cell in the Metazoa.—André **Lwoff**: The nutrition of the Infusoria. Although, under natural conditions, the nutrition of free infusoria is purely phagocytic, it is possible, in a suitable medium, to feed some species by means of dissolved substances.—Boris **Ephrussi** and André **Lwoff**: The double cyclic periodicity of the zone of division in *Colpidium colpoda*.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 9, No. 1, January).—H. W. **Brinkmann**: On Riemann spaces conformal to Euclidean space. An n-dimensional Riemann space can be "imbedded" in an $(n+2)$-dimensional Euclidean space.—O. **Veblen**: Equiaffine geometry of paths. A definition of volume which generalises that used in Riemann geometry is derived.—L. P. **Eisenhart**: Affine geometries of paths possessing an invariant integral.—J. R. **Kline**: Closed connected sets which are disconnected by the removal of a finite number of points.—R. S. **Woodward**: Some extensions in the mathematics of hydromechanics. A development of some of the equations used to describe fluid motion when viscosity is taken into account.—P. D. **McMaster** and P. **Rous**: Hydrohepatosis, a condition analogous to hydronephrosis. Prolonged obstruction of the bile duct in dogs causes distention of the duct and of the gall-bladder with "white-bile," a colourless, watery fluid. A pressure obstacle causes reduction in total secretion and in the percentage output of some of the substances secreted, as in kidney obstruction, though the distention caused is less marked.—H. **Laugier** and R. **Legendre**: Novocaine and curarisation. Novocaine causes morphological changes in nerve fibre, and a solution (1 in 10,000) in physiological salt solution causes an increase in the intensity of a suddenly established current necessary to provoke visible muscular contraction, and decreases the interval before response occurs.—F. G. **Benedict** and E. G. **Ritzman**: Under-nutrition and its influence on the metabolic plane of steers. Eleven adult steers were fed for about 4½ months on one-half their original maintenance ration. Changes in body tissue were measured by the carbon dioxide output, using a respiration chamber. At first there was rapid reduction in live-weight, due to changes in intestinal ballast or fill; afterwards there was slow steady loss, due to drafts on body material; and

during the last few weeks the weights were practically constant. The animals remained active, but the pulse dropped from 44 to about 28. Maintenance level of metabolism in control beasts was 2150 calories per 24 hours per square metre of body surface; for the underfed animals it was 1475. On refeeding, the animals rapidly regained weight and were readily fattened. The energy value of the fæces remained practically constant at 4·778 calories per gm. of water-free substance under all feeding conditions.—C. G. **Darwin**: A quantum theory of optical dispersion (see NATURE, December 23, 1922, p. 841).—W. H. **Cole**: Circus movements of Limulus. The animals were subjected to diffuse and non-directive illumination, and only one lateral eye was allowed to function. In accordance with Loeb's tropism theory, the diameter of the circles traced out was inversely proportional to the intensity of the light.

(Proc. Vol. 9, No. 2, February).—R. W. G. **Wyckoff**: On the hypothesis of constant atomic radii. Starting from cæsium dichloro-iodide, values have been calculated for the "spheres of influence" or atomic radii of several atoms. These values are compared with the corresponding observed interatomic distances. Many discrepancies occur, showing that it is not in accord with experiment to assign a definite size to each atom. In some groups of isomorphous compounds composed of two kinds of atoms a law of constant atomic radii appears to hold. In compounds of different crystal structure, in which the manner of arrangement of the atoms of one kind about those of another (atomic environment) is different, the interatomic distances are unlike.—A. Van **Maanen**: Photographic determination of parallaxes with the 100-inch reflector (Mount Wilson). Four fields have been measured, including the helical nebula (N.G.C. 7293). Using the parallax derived, +0·058, the object appears to have a diameter 375 times that of the solar system.—H. **Shapley**: Light and colour variations of Nova Aquilæ 1918.4. The nova was a star (10-11 mag.) at least 30 years before its discovery. Rise in brightness began on June 7, 1918, reached a maximum, at visual magnitude −1·2, in two days, when it was brighter than any star in the sky except Sirius, and decreased four magnitudes by June 25. Semi-periodic fluctuations occurred until October, with decreasing brightness, and since then it has continued to decrease until it is now about magnitude 10.—E. H. **Hall**: A theory of the Hall effect and the related effect for several metals. When a magnetic field acts at right angles to a current flowing along a thin strip of metal, the equipotential lines are no longer at right angles to the line of flow (Hall effect) and a transverse temperature gradient is set up (Ettingshausen effect). Analogous effects are obtained if heat is flowing along the strip. The explanation offered assumes that conduction implies the existence of two streams, one of free electrons and the other of associated electrons, which oppose each other.—F. B. **Sumner**: Studies of sub-specific hybrids in Peromyscus. Three different crosses between geographic races of deermice were studied in respect of 17 quantitative characters. The mean values for any character in the hybrid is usually between the parental values. Means for the two hybrid generations (F_1 and F_2) generally agree. There appears to be a tendency towards increase of variability which is not due to environmental factors. Most of the elements of the total sub-specific complex seem independent of each other in inheritance, and no single character behaves in obvious Mendelian fashion.—G. A. **Miller**: Sets of conjugate cycles of a substitution group.—A. **Carrel**: Leucocytic secretions. Evidence was obtained of the production of substances promoting growth of homologous fibroblasts and destroying foreign erythrocytes, both *in vitro* and *in vivo*. This supports Renaut's view that the function of the white corpuscles of the blood is to bring nutritive substances to the fixed cells of the tissues, and it also appears that they can bring regenerative substances to injured adult tissue. A foreign protein added to leucocytic cultures increases the production of growth-activating substances; *in vivo* this may precede the production of anti-bodies.—W. M. **Davis**: Drowned coral reefs south of Japan. Some of the Riu Kiu and Bonin Islands are on the margin of the coral seas of to-day; they have no regular sea-level reefs, though their shore-lines resemble those of the embayed islands of the coral seas. The islands may have been protected by reefs while suffering erosion during a period of greater emergence followed by relatively slow submergence. Continued upward growth of the protecting reefs has possibly been inhibited by decrease of ocean surface temperature. A temperature high enough for the growth of the suggested coral reefs may have been caused by the deflexion of the North Equatorial current of the Pacific when the ocean surface was lowered during the Glacial epochs.

CALCUTTA.

Asiatic Society of Bengal, March 7.—Lily **Strickland-Anderson**: Music and the Hindu Pantheon. An attempt to apply the principle that Hindu mythology represents a kinetic or fluidic and not a static or concrete mode of thinking, to the Hindu Pantheon, specially relating to music.—K. G. **Sinha**: On some Maithili dramas of the seventeenth and eighteenth centuries. An attempt is made to explain the nature and importance of the dramas as throwing light on the development of Mithilā art and culture.—C. V. **Raman**: (1) A theory of the viscosity of liquids. An attempt is made to calculate the viscosity of liquids theoretically on the basis of the molecular hypothesis. (2) The molecular ælotropy of liquids. The optical anisotropy of the molecules evidenced by experiments on the scattering of light is discussed, and an attempt is made to find how the molecules influence each other's position and orientation.—N. **Annandale**: Bivalve molluscs injuring brickwork in the Calcutta docks. A note on injury done to brickwork by the boring mollusc *Martesia fluminalis* and on other molluscs associated with it.—P. **Brühl** and K. **Biswas**: On a new species of Cylindrospermum from Bengal. Description of a new species, *Cylindrospermum doryphorum, sp. nova*, Brühl et Biswas. Comparison with known species.—L. Dudley **Stamp** and L. **Lord**: A preliminary note on the ecology of part of the riverine tract of Burma. The area dealt with embraces a zone of country on either bank of the Irrawaddy river between Prome and Yenangyaung, which covers more than 4000 square miles. The inter-relationships existing between the geological formations, soils, climate, and the distribution of the vegetation are traced in detail. The plant formations are classified into 13 groups and the investigation revealed that climate, especially rainfall, is really the main determining factor in the development of any particular type of vegetation within this region.—S. L. **Hora**: Zoological results of a tour in the Far East. (Fish, Part I.) The first part of a report on a collection of fish from a maritime lagoon connected with the Gulf of Siam which contains water of very variable salinity. Forty-eight species of the Selachii and of seven teleostean orders

are discussed. A new species of pipe-fish, and one of Mastacembelus, are described and also a new colour form of *M. armatus*.—B. Prashad: Revision of Kobelt's nomenclature of the Indian Ampullariidæ.

Official Publications Received.

South Australia: Department of Mines. Mining Review for the Half-Year ended 30th June 1922. Compiled by Lionel C. E. Gee. Pp. 64. (Adelaide.)

South Australia. Annual Report of the Director of Mines and Government Geologist for 1921. Pp. 10+2 maps. (Adelaide.)

The Carnegie United Kingdom Trust. Ninth Annual Report (for the Year ending 31st December 1922) submitted by the Executive Committee to the Trustees on Friday, 9th March 1923. Pp. xii+63. (Edinburgh.)

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 52, July to December 1922. Pp. vi.+151-324+12. (London: Royal Anthropological Institute.) 15s. net.

Ministry of Public Works, Egypt. Report on the Work of the Physical Department for the Year ending 31st March 1922. By Dr. H. E. Hurst. Pp. 22. (Cairo: Government Printing Office.) P.T. 5.

Regenwaarnemingen in Nederlandsch-Indië. Twee en Veertigste Jaargang, 1920. Pp. vi+123. Drie en Veertigste Jaargang, 1921. Pp. iii+123. (Weltevreden, Java: Landsdrukkerij.)

Annual Reports: The Academy of Natural Sciences of Philadelphia for the Year ending 30th November 1921. Pp. 74. (Philadelphia.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 74, 1922. Pp. iii+313+22 plates. (Philadelphia.)

Annals of the Missouri Botanical Garden. Vol. 9, No. 3, September. Pp. 233-332. (St. Louis, Mo.) 1 dollar.

Library of Congress. Report of the Librarian of Congress and Report of the Superintendent of the Library Building and Grounds for the Fiscal Year ending 30th June 1922. Pp. 209. (Washington: Government Printing Office.) 50 cents.

Diary of Societies.

MONDAY, APRIL 23.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. D. Anderson-Berry: Occultism: at the Bar of Philosophy and Religion.

ROYAL SOCIETY OF MEDICINE (General Meeting), at 5.—Sir Archibald Garrod, Dr. F. J. Poynton, Dr. M. Cassidy, and Dr. A. F. Hurst: Discussion on The Ætiology and Treatment of Osteo-arthritis and Rheumatoid Arthritis.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Syphilis.

INSTITUTION OF MECHANICAL ENGINEERS (London Graduates' Section), at 7.—S. H. G. Warne: Recent Steam-Wagon Progress, and a Suggested Design.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. H. Shaughnessy and others: Discussion on Practical Broadcasting.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—W. G. Newton: The Literature of Architecture.

ROYAL SOCIETY OF ARTS, at 8.—E. Kilburn Scott: Nitrates from Air (3). (Cantor Lectures.)

FARADAY SOCIETY (at Chemical Society), at 8.—J. H. Shaxby and J. C. Evans: The Properties of Powders—The Variation of Pressure with Depth in Columns of Powders.—E. E. Walker: The Properties of Powders. Part VI. The Compressility of Powders. Part VII. The Distribution of Densities in Columns of Compressed Powder.—E. K. Rideal: The Rate of Hydrogenation of Cinnamic and Phenylpropiolic Acids.—A. Taffel: The Temperature of Maximum Density of Aqueous Solutions.—L. Anderson: Note on the Coagulation of Milk by Acid.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Dr. C. F. Sonntag: Some Points in the Comparative Anatomy of the Mouth and Tongue.—G. J. Harborow: A Case of Unerupted Incisors and Canines in a Male aged 59.—E. Sprawson: The Vascular Supply of the Enamel Organ of *Felis domesticas*.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—L. M. D. Buxton: Inner Mongolia.

TUESDAY, APRIL 24.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: The Machinery of Human Evolution (3). How New Features are Gained.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. C. Gouldesbrough: Osteo-arthritis of the Spine.—Dr. H. L. Tidy: Glandular Fever and Infective Mononucleosis.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—R. B. Murray: Exhibition of a Giant Centipede from Trinidad, and Mounted Skins of Oil-birds.—Lt.-Col. S. Monckton Copeman and Major E. E. Austen: Exhibition (with photographs) of a unique British Dipteron, taken on Primrose Hill.—Baron F. Nopcsa: The Origin of Flight in Birds.—E. C. Stuart Baker: Cuckoos' Eggs and Evolution.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Capt. J. W. Bampfylde: Photomicrography as applied to the Iron-Carbon.

WEDNESDAY, APRIL 25.

ROYAL SOCIETY OF ARTS, at 4.30.—Conference on the Milk Question.—Papers: Prof. R. S. Williams: The Arguments for maintaining an Open Market for Fresh Milk.—Prof. J. C. Drummond: Changes in the Digestibility and Nutritive Value of Milk induced by Heating.—Dr. S. S. Zilva: The Effect of Heat on some Physiological Principles in Milk.—Capt. J. Golding and Mrs. A. T. R. Mattick: A Demonstration of some of the Chemical Changes in Milk on Heating to various Temperatures.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.—C. Baker: Junior Engineer Metallurgical Microscope and the Greenough Binocular Microscope.—R. and J. Beck, Ltd.: New Research Outfit for Metallurgical Work, including Microscope, Camera, Optical Bench, etc.—Edison Swan Electric Co., Ltd.: Projector and Fullolite Lamps.—M. P. Swift: Use of Dichroiscopes for the Identification of certain Gem Stones.—W. Watson and Sons, Ltd.: Petrological Microscopes.—At 8.—J. E. Barnard: The Manipulation of the Microscope in Industrial Laboratories. Part I. Illuminants and Illumination.—Dr. M. C. Stopes: The Microscopical Examination of Coal in relation to Fuel Economy and Efficiency.

BRITISH PSYCHOLOGICAL SOCIETY (Medical and Education Sections) (at London Day Training College), at 8.—Drs. East, Burt, Shrubsall, and Stoddart: Symposium on Delinquency and Mental Defect, to be followed by a discussion.

THURSDAY, APRIL 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. T. MacGregor-Morris: Modern Electric Lamps (1). Glowing Solids *in vacuo* (Tungsten Lamps).

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton and R. C. Johnson: Spectra associated with Carbon.—R. A. Watson Watt and Dr. E. V. Appleton: The Nature of Atmospherics.—Prof. W. A. Bone, D. M. Newitt, and D. T. A. Townend: Gaseous Combustion at High Pressures. Part III. The Energy-absorbing Function and Activation of Nitrogen in the Combustion of Carbon Monoxide.—Dr. I. Masson and L. G. F. Dolley: The Pressures of Gaseous Mixtures.—W. R. Bousfield and C. Elspeth Bousfield: Vapour Pressure and Density of Sodium Chloride Solutions.—Prof. F. A. Lindemann and G. M. B. Dobson: A Note on the Temperature of the Air at Great Heights.—Prof. G. H. Hardy and J. E. Littlewood: Lindelöf's Hypothesis concerning the Riemann Zeta-function.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Grace Chisholm Young: The Solution of a Pair of Diophantine Equations connected with the Nuptial Number of Plato.—H. W. Richmond: (1) The Electrostatic Field of a Plane Grating with Thick Rounded Bars; (2) Notes on the use of the Schwarz-Christoffel Transformation in Electrostatics.—E. G. C. Poole: The Discontinuous Motion produced in an Infinite Stream by Two Plane Obstacles.—A. E. Ingham: Two Mean Value Theorems concerning Riemann's Zeta-function.—A. E. Jolliffe: The Inflexions of the Non-singular Plane Quartic.—R. Vaidynathaswami: Transversal Problems in Hyperspace.—T. Stuart: Certain Diophantine Equations.—M. Riesz: Sur l'équivalence des certaines méthodes de sommation.—K. Basu: The Perturbations of the Orbit of the Valency-electron in the Generalised Hydrogen-unlike Atom.—Pandit Oudh Upadhyaya: Cyclotomic Heptasection.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 5.30.—Annual General Meeting.—At 6.—Dr. W. G. Sleight: Children's Taste in Pictures.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. Breach and H. Midgley: The Drive of Power Station Auxiliaries.

SOCIETY OF DYERS AND COLOURISTS (London Section) (at Dyers' Hall, Dowgate Hill), at 7.—L. G. Lawrie: Fur Dyeing.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30—Clinical and Pathological Evening.

FRIDAY, APRIL 27.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botany Theatre, Imperial College of Science and Technology), at 2.30.—Dr. C. M. Wenyon: Some Recent Observations on Pathogenic Protozoa of Plants and Animals.—(To be followed by a discussion.)

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—(Epidemiology and State Medicine Section), at 8.—Dr. T. F. Dewar: The Incidence of Venereal Disease in Scotland.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—The Research Staff, General Electric Co., Ltd.: The Analysis of Bubbles in Glass.—Dr. H. P. Waran: A Simple Regenerative Vacuum Device, and some of its Applications.—Capt. H. Shaw and E. Lancaster Jones: Application of the Eötvös Torsion Balance to the Investigation of Local Gravitational Fields.—L. F. Richardson: Demonstration of an Electromagnetic Inductor.—Dr. F. Ll. Hopwood: Demonstration of Experiment Illustrating Time-Lag in Vision.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Surgical Anatomy of the Foot.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Adjourned Discussion on paper by A. E. L. Chorlton: The Use of Light Alloys in place of Iron and Steel.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. Fearn: Stock Control.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—A. Watkins: Early British Trackways.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. C. V. Boys: Measurement of the Heating Value of Gas.

SATURDAY, APRIL 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. L. L. B. Williams: The Physical and Physiological Foundations of Character (1).

PUBLIC LECTURE.

WEDNESDAY, APRIL 25.

KING'S COLLEGE, at 5.30.—The late Prof. E. Troeltsch (by Dr. E. Barker): Ethics and the Philosophy of History. (Succeeding lectures on May 2 and 9.)