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Popularisation and Sensationalism.

THERE can be no doubt that at the present day the question of the popularisation of science has acquired new interest and importance; it has been for some time an increasingly recurrent theme in our columns. The times seem in many ways to offer a new opportunity; great things—very great things—have been occurring in science, and in view of them we realise more than ever the grievousness of our intellectual condition, a condition where not only the multitude lie in ignorance but also where those who pass as the best informed have been left by their higher education without eyes to see, or ears to hear, the greatest happenings in the progress of human knowledge.

There is, we must gladly admit, evidence of an awakening, of some growing sense of shame, and of a genuine and widespread desire to learn. Among those who direct the newspaper press, which, we are assured, reflects rather than leads public opinion, there are signs of an increasing disposition to bring science into the daily diet they provide. In a certain number of cases, science has become what is technically known as a "feature"—like the music and art columns; and it has even shown the possibility of providing at times a "scoop." Broadcasting, again, is opening up new channels of communication which, if properly used, may be of unequalled importance in creating among the multitude an intelligent interest in science.

It seems to us very important that at this juncture, men of science should be alert to seize their opportunities and that they should respond in every legitimate way to the growing demand. They should bend themselves to the task of translating science to the public and of giving all the knowledge that is possible of its meaning, its methods, and its march. We need scarcely add that the task is one of very great difficulty. The public must have what the public wants: if it desires to be informed, it demands before that to be interested. Its own point of view, its primitive state of knowledge in all that relates to science, must be carefully regarded. Liveliness of exposition is as necessary as lucidity. The thing can be done—it is well worth doing; and though it seems at present there are not many, we believe that there might, by taking thought, be many more who know exactly how to do it.

There is no doubt that many men of science shrink under the demand for popularisation, not only because it would divert them from what seems more serious work, but also because it threatens a loss of self-respect. We can all understand and sympathise with their apprehension, and it is only fair to say that to-day the position is becoming more difficult. The public

expectations of new marvels from science have been greatly stimulated; science gives a new promise of material for leaded type and heavy headlines, it may even reach the evening "contents" bill; camera-men are in waiting at every corner.

It is easy to understand the reluctance, which all this inspires in modest men, to venture on the territory of press publicity, and to incur the risk of inclusion with charlatans whose "amazing" discoveries still find so ready an acceptance there. We believe, however, that the risk is worth while and that with reasonable care the dangers can be avoided. Vigilance is, however, becoming increasingly necessary, and it is of the first importance that public opinion within the scientific world should express itself plainly when this vigilance is neglected.

It is with this sense of obligation that we feel compelled to express very great regret that, in one of the younger universities, the dignity of science should recently have been allowed to undergo what seems to us to be a very serious violation. We shall not attempt to enter into details, nor do we desire to particularise individuals. The essential fact is that a want of vigilance has led to an exhibition of vulgar sensationalism which, as we are well assured by the remonstrances that have reached us, is regarded by the reputable scientific world as being in the highest degree deplorable. We make no attempt to apportion blame; we are concerned only to enter a strong protest. It is possible that what has happened may act as a temptation to a few of the less thoughtful to the empty glories of the limelight. In so far as that is the case, it will, we trust, stir responsible people to the exercise of restraint. We do not think the chief apprehension lies in that direction. We fear rather that what has happened may prove to have given a serious set-back to the efforts, which have recently been showing more success, to induce our men of science to help in a wholesome alliance with the Fourth Estate in what, properly regarded, has the sanctity, and should have the sobriety, of a missionary effort of enlightenment. We can only hope that what has recently happened will leave behind nothing but a salutary warning.

There is at the present time great restlessness in the world; old landmarks and fixed points, and even rules of life, seem to have disappeared, and we are in the turmoil of readjustments on the grand scale. Amid the grave anxieties of this condition we have a temporary excitement breaking out here and there in all sorts of morbid forms. By coincidence we have in the world of science a corresponding stir of readjustments; let us see to it that we at least are not invaded by the discordant spirit of jazz.

The Human Factor in Coal Mining.

ON October 2 the Institution of Mining Engineers held its annual meeting, at which Prof. J. S. Haldane was inducted into the presidential chair and gave his presidential address. The occasion was sufficiently unusual to merit special comment. It is not an ordinary occurrence for the president of an engineering institution to be a professor of physiology; but Prof. Haldane is no ordinary physiologist. He has practically devoted his life to a study of the physiological problems which the miner's occupation presents, and to the discovery of how the miner's health and safety of life and limb are affected by the incidence and accidents of his occupation, and how the ill-effects of these can be guarded against. It is not too much to say that it is to Prof. Haldane's studies that thousands of coal miners in Great Britain owe their lives and health to-day, and that he has played a leading part in the battle against the dangers of the industry which mining engineers are waging with such conspicuous success that coal mining in Great Britain is safer than in any other country in the world.

As might well be expected, Prof. Haldane's presidential address had in it nothing at all technical; it was essentially humanistic and laid stress upon that most important of all factors in any engineering industry, namely, the human element. He pointed out that one of the most striking characteristics of mining men is the deep and sincere feeling of comradeship that unites all classes amongst those actually engaged in mining work; or, as he put it: "I have often been present at a colliery during some time of trouble or danger; and it was this comradeship, from highest to lowest, that impressed me most. But whether or not unusual trouble is present, one seems to meet comradeship as one enters the colliery premises or steps into the cage." He points out that it is this readiness with which miners "will give loyal and efficient service, will face any danger, will forgive imagined or real mistakes, and will take the rough with the smooth, the bad times with the good," that makes the miner insist upon his right to be treated as a man and not as a machine; and Prof. Haldane expresses his strong view that this feeling is really at the bottom of the so-called industrial unrest amongst miners. As he puts it: "Neither high wages, high dividends, nor welfare schemes will satisfy them in this respect, but only discerning and sympathetic treatment, the treatment of comradeship in a common enterprise—such comradeship as existed in and between all ranks during the War, or such comradeship as is taught in the Gospels."

Prof. Haldane makes clear that his experience has taught him that the mining engineer and mine manager,

unconsciously perhaps, but nevertheless quite sincerely, feel this attitude on the part of their men, and that they fully sympathise with it and endeavour to give it every opportunity for expression within the limits which they find possible, having regard to the safety and well-being of the men themselves. In this sense a coal mine "is the outcome of human comradeship, which uses in its own way, and of its own free will, the tools provided by physical and economic knowledge."

Throughout his address, Prof. Haldane shows clearly that he thoroughly appreciates the existence of the feelings of true cordiality, regard, and esteem which employers and employed in the coal-mining industry really entertain for each other, but which as a rule are not evident to those outside the industry, whereas the public at large, seeing only the surface of things, may well be inclined to disbelieve in their existence. Those engaged in the industry know well enough, for example, that during the recent long-drawn-out disputes, colliery owners and managers actually assisted from their funds the strikers of their own pits to tide over that period of hardship, but the general public never hears a word of such kindly actions. Constantly during the recent disputes one heard the opinion expressed by both sides in colliery districts that, if only the busybodies at headquarters would leave them alone, they could settle their own differences readily and amicably.

Prof. Haldane is one of the few who has rightly gauged the feelings of the average colliery manager and coal miner for each other, and he lays stress, as its importance deserves, upon this phase of the relations between masters and men, though he at the same time shows that coal mining must, in the interests of the nation itself, necessarily be so carried on as to be commercially remunerative to all concerned therein, and that the responsibility for seeing that the industry is thus able to pay its way rests primarily on the mining engineer. In Prof. Haldane's own words: "When we realise the actual responsibility to their fellow-countrymen of those whose duty it is to care for the financial soundness of the operations involved in British colliery undertakings, we see at once how great that responsibility is, and how important it is that sufficiently far-seeing men should bear it, and should not be suffered to be interfered with by ignorant persons, who are commonly officious in direct proportion to their ignorance."

Prof. Haldane's address is, as we have said, unique in the occasion of its delivery. It is also an outstanding example of the fact, too rarely recognised, that the scientific worker is better able than most men to see the spiritual side of human endeavour, and that no man can be a true physiologist without having at the same time a profound insight into the problems of psychology.

A Veteran's View of Modern Physics.

Atoms and Rays: an Introduction to Modern Views on Atomic Structure and Radiation. By Sir Oliver Lodge. Pp. 208. (London: Ernest Benn, Ltd., 1924.) 21*s.* net.

THE writing of a popular account of recent advances in any branch of science calls for many qualities if it is to be successful. The author must, in the first place, be able to interest and hold the reader without recourse to sensationalism, a truism which, like many other truisms, is often overlooked. He must be the master of clear and concise English, and remember that many words which have a special and defined significance for the expert have also a general meaning which is much more vague. He must have sufficient critical faculty to be able to select for emphasis the points which are really fundamental, and sufficient adaptability to feel when detail must be sacrificed for the sake of vividness. Above all, he should be able to make the reader see in the researches which he describes an example of the power and beauty of the true scientific method, as contrasted with the inspired guesswork to which the ordinary reader is apt to attribute the advances of science.

Sir Oliver Lodge possesses all these virtues, and, in addition, his own distinguished career as an investigator has left in him an informed enthusiasm which he is well able to communicate. He is a veteran who sees in the modern campaigns against the unknown a repetition, governed by the same general rules of war, of those earlier ones in which he was a leader, and he speaks with the authority of one who knows the conditions of the conflict, as against those who, having never seen the battle raging, attempt to develop an account of the hostilities from the dry despatches. Nearly twenty years ago he gave us, in his "Electrons," the best general account of the state of the electron theory at that time. Towards the end of that book he mentioned various theories of atomic constitution, and spoke of the "exaggerated uncertainty" of the position with special reference to Sir J. J. Thomson's contention that the atom of hydrogen contained only one electron. He also had something to say of the difficulties in the way of explaining line spectra. To-day he has to tell how the advances of the last fourteen years or so have brought clearness into the subject of the structure of the atom, of the quantum theory, of how Bohr's application of it has gone far to found a reasonable theory of spectra, and, in general, of the present state of the electrical theory of matter and the associated radiation problems. He appeals to a wider audience than he did in the earlier book, for very little general knowledge of physics is now assumed in the reader,

and such mathematical treatment as there is requires for its comprehension but an elementary knowledge of algebra.

The book does not present a strictly consecutive scheme, for Sir Oliver holds that, in the words of his preface, "it is only by treating a subject from many points of view, and by frequent repetition, that it gets any hold on the general mind. Effective exposition cannot be done crisply and compactly." Accordingly, in the first few chapters we find the electron, the nucleus atom, some of the fundamental facts of radioactivity, and other features of modern physics approached in different places from different points of view, a few facts and aphorisms being set down each time a particular problem presents itself. In this way the reader is gradually familiarised with the chief experimental facts and the leading speculations based on them, although, perhaps, a clearer distinction between the two might occasionally be made. We then come to the quantum theory, illustrated by simple examples from everyday life. "One cannot gain half a trick at whist." The analogy used a little later is not so good: we are asked to consider an assemblage of tuning-forks, each with a small pellet suspended so as to touch the prong. When a note of given frequency is sounded the forks of that frequency, and of that frequency only, will throw off the pellets. This is true, but it fails to represent the chief feature of the quantum theory, namely, that the energy with which the electron is flung off is, in cases governed by quantum laws, dependent on the frequency of the radiation, but not on its intensity. This is, of course, pointed out by Sir Oliver elsewhere, but the analogy is a poor one to have introduced.

A brief account of optical and X-ray spectra, followed by a resumed consideration of the nucleus atom, leads into an account of Bohr's theory of the hydrogen atom, to which a large part of the book is devoted. Sir Oliver has set out to give, in the most elementary form, the mathematics of Bohr's explanation of the simplest line spectra, and here he has been most successful. He considers in detail the problem of the simple circular orbit, and carries out the whole of the calculations by degrees over several pages, always explaining the dynamical principles as they arise in the most comprehensible way.

The treatment of heavy atoms is, necessarily, very slight. The physicist will be somewhat surprised at the sense in which the author has used the word *ionisation*, for by it he indicates the removal of an innermost, or K, electron, instead of, as is usually implied, an outer electron. For example, he says, "Even moderately heavy atoms cannot be ionised or dissociated by visible illumination, but can be disturbed by X-ray frequencies: the frequency needed to ionise an oxygen atom, for instance, should be sixty-four times that which is sufficient to ionise hydrogen." It is a pity that the term *ionisation potential*, which already has a perfectly definite meaning, should be thus reapplied to characterise a quite different quantity, while the accepted meaning of the term, which is of such importance for spectral theory, and, moreover, is capable of simple exposition, is altogether neglected.

One of the questions most frequently asked by the interested layman is, to put it abruptly, whether the ether exists or no. The orthodox physicist of to-day would, we take it, after trying to avoid the question, reply that the ether as a substance ceased to exist (or to be a good working hypothesis, if the expression be preferred) when the theory of relativity became established: that we cannot speak of determinable points in the ether, or measure a velocity relative to it, or, in short, endow it with ordinary mechanical properties. On the other hand, there is no objection to calling empty space, in which an electromagnetic field exists, the ether, but to those accustomed to the old substantial ether, this is much like calling a spread table without any food a meal—they ask for bread, and we pass an empty plate, and tell them that they can call its contents what they like. Sir Oliver will, of course, have none of this; he is for the good old ether with mechanical properties—*et plutôt deux fois qu'une, et plutôt trois que deux*. He has many interesting speculations which involve its existence as a fluid: he suggests that it may have a structure, a texture of vortices reminiscent of Descartes, and that propulsion may one day be achieved by a sort of reaction on the massive ether. For the professional physicist, who realises the spirit in which they are put forward, these suggestions and analogous speculations are full of interest, but it would have been well to warn the lay reader, to whose need the book is, in general, so splendidly adapted, of some of the difficulties in the way of a substantial ether.

Again, there are certain calculations which assume that the electronic mass is unaffected by high speeds, calculations put forward because they lead to suggestive coincidences. No one knows better than Sir Oliver that the mass of the electron is not, in fact, constant—indeed, he has clearly expounded this elsewhere—but his lay reader will scarcely know what to make of these calculations. These are examples of our only general criticism of the book, namely, that, for the ordinary reader, there is too little separation of what is well established from what is fanciful speculation. The physicist will follow with delight Sir Oliver in his confident, independent, and characteristically fearless excursions among the more ticklish problems of to-day,

but the less experienced may well wonder occasionally where he is.

When Sir Oliver rises to speak at a scientific meeting, all who know him rouse themselves from their reflections, or apathy, and prepare to hear some simple truths which have, perhaps, been overlooked, wittily and exquisitely expressed. This book has much of the quality of his speeches: it is personal, persuasive, and arresting, conceived in a broad spirit, and full of enthusiasm for progress made in the past, and the possibilities of the future. "The processes of Nature should be enjoyable, even though the enjoyment is laboriously acquired." This sentence of his might serve as motto for a volume that is characteristic of the author, to have said which is to commend the book to a very discerning and comprehensive circle of readers.

E. N. DA C. A.

The Technique of Contraception.

Contraception (Birth Control), its Theory, History, and Practice: a Manual for the Medical and Legal Professions. By Dr. Marie Carmichael Stopes. Pp. xxiii+418+4 plates. (London: J. Bale, Sons and Danielsson, Ltd., 1923.) 12*s.* 6*d.* net.

DR. MARIE STOPES has written a very good book on birth control. Not the least of its merits is a simple directness which marks sincerity and contrasts pleasantly with the sentimental sloppiness which nauseates in many publications on the same subject. She relies on evidence, and marshals it in a clear, readable way. Given her point of view, we may differ from her on minor matters, but on the whole she compels agreement.

One cannot have one's cake and eat it too. Living beings tend to multiply so fast that continuous high birth-rates and low death-rates are incompatible. High rates may coexist for ages, so may low rates; but never for long a high rate of one sort with a low rate of the other. In the end, a rapid increase of population implies a massacre of youth. On the other hand, many deaths and few births imply extinction of the race. Now and then, for limited periods and under special conditions, the demand for human beings may equal and even exceed the supply; but, as a rule, and always in the long run, the reverse is the case. Optimists tell us that Nature will provide for her children. She does—by means of war, or famine, or disease, or lethal hardship, or two or more of these combined. It is conceivable that the earth has resources which would maintain its present human population, multiplied a hundred- or a thousand-fold. But here we have only an ugly dream. Even if the earth, its romance and beauty gone, gradually became a great market-garden under intensive culture, its resources could not be made available fast enough. Demand creates supply; but the latter lags.

The struggle for space and existence is perhaps severest among such primitive savages as live on wild produce, which is usually scanty. Each tribe draws its subsistence from a wide area, within which it murders trespassers, and beyond which it seeks to exterminate neighbours. Contraception is known and practiced, or failing it abortion; or failing the latter, infanticide and neglect of the weak and aged. The taming of wild animals and plants increased production; and in time and for a time the labour of a robust individual gave subsistence for more than himself and his family. Thereupon wars of conquest displaced those of extermination. The strong sought not so much land and elbow-room as slaves, subjects, and tributaries. So men drew into larger aggregates. Civilisation dawned. Commerce became important. Means of communication improved. The deficiencies of one area began to be supplied from the superabundance of others. Finally, men turned more and more from agriculture to the manufacture of things which could be exchanged for food and other articles of use or luxury. During recent centuries this has been especially the case in England, where the great majority of the population is now urban.

For an epoch all went, or seemed to go, well with the British. Not only did they multiply, but wealth also bestowed power to bring food and other raw material from overseas. Presently, however, capital found insufficient opportunities for investment at home and was exported for the development of other lands. The latter soon began to manufacture and sell much they had bought in Britain, and even to export their wealth for more development elsewhere. This process cannot continue for ever. Emigration, which deprives us of some of our best human material, is almost negligible as a remedy. Apart from war, famine, and the like, no means, save contraception, of fleeing from the wrath to come can be thought of. Lacking it, the old savage wars for elbow-room must recur. Germany's struggle was nothing other. The mills of God grind slowly but they grind exceeding small.

Another line of reasoning is more decisive because more obvious. Contraception, whether right or wrong, has come to stay. In growing numbers men and women practise it in secret, and not all the king's horses and all the king's men can prevent them. In this connexion it is remarkable that the clergy, who in theory are the most determined opponents of contraception, have now the lowest, or almost the lowest, birth-rate in the kingdom. France and the United States have passed futile laws against it. During recent years the latter

country seems indeed to have developed a perfect genius for enacting edicts which cannot be enforced.

Dr. Stopes's book contains an introduction by the late Sir William Bayliss, and introductory notes by Sir James Barr and other medical people. Sir William Bayliss questions whether, as Dr. Stopes supposes, the seminal fluid contains hormones which, even in the absence of conception, are absorbed by, and are of value to, the female. The supposition is difficult to test, and Sir William's doubts will be echoed by many readers. The only experimental evidence is that furnished by John Hunter. "The semen would appear, both to smell and taste, to be a mawkish kind of substance; but when held some time in the mouth it produces a warmth similar to spices, which lasts some time." Evidently John Hunter was an intrepid experimenter! Of more than doubtful validity, too, is Dr. Stopes's belief (p. 139) "that in the fully excited uterus the cervix may spontaneously open and interlock with the glans penis." The cervix of the unimpregnated uterus is tough and gristly and its canal is many times too small for the glans.

But these and other speculations are of minor importance. The principal value of the volume lies in a careful and exhaustive discussion of the methods and technique of contraception—ancient and modern, savage and civilised, ranging from major surgical operations to simple and easily manipulated devices. Dr. Stopes's experience, gathered mainly from fertile but overburdened working women, mere drudges, alive but strangers to liberty and happiness, is so extensive that her opinions must necessarily carry weight. She condemns, except in special cases, all measures undertaken by the male, and advises in particular the use of a light rubber, dome-shaped, cervical cap. Of great value also is her history of the struggle to convey contraceptive knowledge to the public. Some such book as this had to be written, and this is very well written.

G. ARCHDALL REID.

The Sense-Organs of Animals.

Allgemeine Zoologie und Abstammungslehre. Von Prof. Dr. Ludwig Plate. Zweiter Teil: Die Sinnesorgane der Tiere. Pp. ix+806. (Jena: Gustav Fischer, 1924.) 22 gold marks.

THIS imposing and beautifully illustrated volume of about 800 pages forms an admirable textbook upon the sense-organs of animals. Its author is well known as successor of Haeckel and Director of the Phyletic Museum at Jena, as one of the most trustworthy of German writers on the philosophy of evolution, and as the author of highly important morphological researches, such as those upon the primitive gasteropods. Prof. Plate is primarily a morphologist, yet he clearly recognises that evolutionary theory, although its record is necessarily morphological, must, if it is to be fruitful, remain in close touch with physiology. Indeed, his book is a good example of what the ideal text-books of general zoology in the future will be in its happy combination of anatomy and physiology.

The volume contains a vast mass of detailed information regarding the sense-organs, but it is no mere aggregation of detail. On the contrary, the facts are well marshalled and fitted into an evolutionary framework that makes the volume, large as it is, most interesting reading. It will prove of great use to the advanced student and also to those who have to lecture to advanced students. Its perusal will prove illuminating alike to the narrow zootomist and the narrow physiologist. The latter, perhaps, accustomed to think of sense-organs entirely in terms of those that happen to exist in man, will have his outlook broadened by learning such facts as that within the group of insects alone, auditory organs have evolved independently by at least eight different methods out of the primitive sensory cells.

The volume is divided into fifteen chapters, dealing respectively with general introductory matter, tactile and other skin sense-organs, lateral line organs, gravitational sense-organs, auditory organs of Invertebrates, auditory organs of Vertebrates, temperature organs, organs of smell and taste, physiological effects of light, eyes of Invertebrates, general review of these, colour-perception, eyes of Vertebrates, pineal organs, and general principles of the evolution of sense-organs.

The introductory chapter deals with basic matters such as the classification of sense-organs, the various types of cell, sensory and accessory, which enter into the composition of sense-organs, and the various arrangements for receiving and transmitting the sensory stimulus. The following chapters, constituting the main part of the volume, deal with the various sensory apparatuses in detail. The mass of information is far too great for detailed notice in a short review; each chapter constitutes an excellent survey of its particular subject-matter. A particularly interesting one is that dealing with the auditory organs of terrestrial invertebrates. Thus about 25 pages are devoted to these organs as they occur in insects. The structural arrangements of chordotonal organs are first described, their function being regarded as that of the detection of simple vibrations. The various types of auditory organs are regarded as evolutionary developments from chordotonal organs, the original function of perceiving simple vibrations, possibly in correlation with control of wing movements, having become specialised in the direction of appreciating sound. Such organs are seen in the

tympanic organs present in cicadas, crickets, grasshoppers, and many sound-producing Lepidoptera, the organ in each of these types of insect presenting characteristic peculiarities in detail which suggest that they have evolved independently from the ancestral chordotonal organ. Ignoring such differences in detail, the tympanic organ consists of a piece of body-wall so thinned out as to form a delicate vibratile membrane separating the outer air from an internal air-filled cavity formed by the dilatation of a tracheal trunk, and having in relation to it peculiar sensory cells of the same type as those seen in the chordotonal organs.

The succeeding chapter gives an interesting account of the vertebrate type of auditory organ. The author follows the fashionable practice of using the word statocyst rather than otocyst. This practice is, on the whole, to be regretted. Either name is no doubt in itself beyond criticism, but otocyst has an important practical advantage in teaching, inasmuch as it brings the less familiar type of organ and function into relation with the more familiar instead of conversely. It is also perhaps to be regretted that the author has not simply ignored the sterile morphological controversy regarding the homologies of the malleus and incus of mammals. Morphologists of the future will undoubtedly marvel at the greatness of the faith of those who have regarded the developmental phenomena exhibited by malleus and incus in the embryo, and the palæontological facts which have been interpreted in accordance with them, as being of weight sufficient to overcome the physiological improbability of (1) new skeletal elements becoming intercalated in a structure which must have been freely movable throughout its functional history, and (2) the articulation between jaw and skull being replaced by another joint without break of functional continuity. Apart from such matters of opinion, the chapter gives an excellent account of the vertebrate otocyst and its variations, illustrated by a wealth of admirable figures, among which we are glad to notice Gray's beautiful photograph of the otocyst of Echidna.

In a work on the sense-organs, some of the most interesting chapters are naturally those which deal with sight. In this volume they occupy about half of the whole. A general discussion is first given of the relations of light to living processes. While the work of Loeb is fully appreciated, Plate is more cautious than many in following this author, and he does not forget to mention Szymanski's interesting experiments on cockroaches, in which he succeeded in teaching them to avoid dark corners by associating with darkness the idea of electric shocks! The detailed description of the various types of eye met with in the invertebrata occupies about 170 pages; it will be of the greatest utility to advanced students desiring to have a comprehensive grasp of eye-structure in all its varieties. A good chapter on the eyes of vertebrates is followed by a short discussion of evolutionary principles in relation to the sense-organs.

The book is admirably got up; it is well illustrated, many of the best illustrations being original; it should find a place in the library of every university department of zoology or physiology. J. GRAHAM KERR.

Pyramid and Prophecy.

The Great Pyramid, its Divine Message: an Original Co-ordination of Historical Documents and Archæological Evidences. By D. Davidson and H. Aldersmith. Vol. 1: Pyramid Records; a Narrative of new Discoveries concerning Civilisations and Origins. Pp. xxvii + 568 (70 plates). (London: Williams and Norgate, Ltd., 1924.) 25*s.* net.

THIS elaborate work is one of the assertionist class which has spread in recent years. The pyramid theories open with many pages on the reflecting surfaces of the Great Pyramid, fixing accurately the days of the solstices and equinoxes. Now such porous limestone cannot be polished to reflect, or even to glitter; and a diffuse faint glare at best, without any definite limit, would be entirely useless to define a given day in the year, as here asserted. Then we read of the shadow on a face being only exact once in a century, and approximately every fourth year. As at that time of year the change of declination of the sun, by the shift of 0·242 day, from year to year is under 6′—less than a fifth of the sun's diameter—the difference between one year and another would be imperceptible to the eye.

The theories here depend on the size of the pyramid base. This was really 9069 inches; the rock sockets into which the sides sloped down below the base vary from 9119 to 9131 apart, according to their depth. To attain the theoretical base of 9141 inches, ten inches is added to the longest side without any authority whatever. The actual diameters across the pyramid show 9069 inches, but it is asserted that the sides were curved so as to bring out the corners to the amount required by the theorists.

The historical treatment likewise depends on assertion. It is assumed that a year of 360 days was used concurrently with one of 365 days, and during long ages a cycle of 103 years resulted. This is highly improbable, and there is no proof of such a mixture. The cycle of 103 years is then used in various forms, though no such cycle is known; the calendar is asserted to have been revised and altered, but there is no proof of it. We read of "fictitious chronology of the Egyptians" and "Jewish chronological forgeries" when the records are not convenient.

A typical argument runs thus: Certain dated quarry marks are assumed to be on a fixed and not a rotating calendar; that throws the quarrying into the hot season; then that proves quarrying to have been done in the hot season; and that proves that a fixed calendar was used—exactly the assertion made to begin with. The years recorded in Egyptian history are asserted to have been copied from the dimensions of the Great Pyramid in inches, though it is said that "the compilers of the kings lists added the measurements of radii to the measurements of arcs, horizontal to vertical distances, and totalled measurements in cubits together with measurements in inches." Such is what the authors have to do to produce their coincidences. All of this is introductory to the prophetic detail of the passages of the pyramid (including the exact length of the recent War), Christian chronology, and innumerable vexed questions, which are all solved by asserted connexions. It is sad to see such labour and expensive publication devoted to confusing the public mind.

Ores as Igneous Rocks.

The Ore Magmas: a Series of Essays on Ore Deposition. By J. E. Spurr. Vol. 1. Pp. x+430. Vol. 2. Pp. ix + 431-915. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 2 vols., 40*s*.

THESE two interesting and suggestive volumes consist of essays on ore deposits based on Mr. J. E. Spurr's varied personal experience of American mines, which include so many types that they illustrate the chief phenomena of ore formation. Mr. Spurr shows in this work the clearness of insight, caution, and scientific ability which have made his contributions to economic geology of special value. He was one of the pioneers of the school which attaches predominant importance to igneous action in the formation of ores. He emphatically rejects lateral secretion or the formation of ores by surface waters, and also by the agency of deep-seated hot springs, as no water circulation could explain such facts as the enormous concentration of copper ores in Arizona. He insists, moreover, that ores have been made by processes that do not operate in any accessible zone of the crust, as he has not seen in the deepest mine visited any lode in process of growth.

Mr. Spurr early adopted the view, from his work in Alaska, that there is no sharp line of division between mineral veins and igneous dykes. His "alaskite," a name now generally adopted in geology for a group of quartz-alkali-felspar dyke rocks, he regards as passing imperceptibly to arizonite, or quartz veins formed as the most acid differentiation product. He calls such intermediate types vein-dykes. He unfortunately has not seen the memoir by Belt, who in 1861 advocated the igneous origin of many Australian quartz veins. Mr. Spurr knows that work only by the reference to it in Belt's "Nicaragua"; he quotes A. W. Howitt, however, who temporarily adopted Belt's hypothesis, but took a wrong turning when he abandoned it and became a lateral secretionist. The origin of the injection of the vein-dykes Spurr attributes, not to crustal pressure, but to some force inherent in the material, which he suggests is gas pressure. This force is sufficiently powerful to tear ruptures many miles in length through rocks, as the evidence is clear that many ore veins did not enter pre-existing fissures. He attributes the ultimate origin and distribution of the chief ore deposits to the effects of magmatic migration during sub-crustal flow. He recognises three types of movements: the horizontal pressure around the uprisen molten masses produces overfolds and overthrusts; the blocks above an intrusion are uplifted by "injection faults"; and the down-sagging of the areas undermined by sub-crustal flow produces "adjustment faults." In connexion with the intrusion of igneous rocks he discusses Daly's theory that the great plutonic masses have worked their way upward by overhand stoping, and also the explanation previously adopted that some igneous rocks have replaced an equal bulk of sediment by assimilation. He rejects both explanations, as in his experience the field evidence gives no adequate corroboration for either. The two last chapters deal with injection breccias, and ore-chimneys, which he refers to exceptional earth movements also due to igneous intrusions.

Some geologists may think that the author attributes too great a rôle to igneous activity, as that theory is inapplicable to some types of ore deposits; but for many of the most important ores the author's conclusions appear sound, if it be understood that his conception of magmatic action lays stress on magmatic waters and not on simple fusion. Many of the author's conclusions have a bearing on wider problems than those of profitable mining. The fore-deeps of the Pacific the author attributes to down-sagging around the uplifted continental blocks, and he remarks the similarity in Kainozoic volcanic activity and ore formation all around the Pacific. This view attributes the existing Pacific basin as a whole to Kainozoic movement, and the author remarks that we are still living in the "Tertiary catastrophic period." The widespread crustal disturbances are also shown by long fissures which have been proved by mining to cut across the country independent of the mountain folds. They are therefore due to the fault movements that followed the last great epoch of mountain folding.

Mr. Spurr's work illustrates the important light thrown by mining geology on the structure and the physical geography of the earth's crust. J. W. G.

Our Bookshelf.

The Calculation and Measurement of Inductance and Capacity. By W. H. Nottage. Second edition. Pp. viii+224. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1924.) 7*s.* 6*d.*

MANY problems in connexion with obtaining formulæ for the inductance and capacity of various conductors and systems of conductors have recently been solved.

As these solutions have usually been given in papers contributed to learned societies in various countries, it is a convenience to have them collected together in a single volume. As a rule the formulæ are very lengthy and laborious to calculate, and hence we think that more references should have been given, as in some cases the limitations of the formulæ have not been stated. We were surprised that no formula is given for the inductance of a concentric main. It is true that in most cases with low frequency it can be neglected, but in radio work it is often of importance. On p. 65 a formula is given for the *average* potential of a single straight wire. We quite fail to understand what this means, as, being a conductor, it is presumably at the same potential throughout.

We were interested to see how rough calculations and empirical formulæ gave results which agree closely with the measured values. As in the measured values the resistivity of the earth has to be taken into account, it looks as if—at least on dry days—this resistivity can be taken as constant. Numerous methods of measuring capacity and inductance are given, but it would be a help if it were pointed out which are the most suitable for special cases. Descriptions are also given of the numerous appliances that are used for making these measurements. It is surprising that in a second edition Kirchhoff's name is persistently spelt with one *h*.

Trattato di chimica generale ed applicata all' industria. Per Prof. Dott. Ettore Molinari. Vol. 1. *Chimica inorganica.* Parte prima. Quinta edizione riveduta ed ampliata. Pp. xv+680. (Milano: Ulrico Hoepli 1924.) 40 lire.

THE number of books dealing with the whole range of industries to which the description chemical is applicable is very small, and among these Molinari's work, fashioned on a new and original plan, has come to occupy a very definite and important place. The measure of its success may be gauged from the appearance, within the space of less than twenty years, of four editions in Italian, each in turn rapidly exhausted, two in English, two in Spanish, and one in French. The present volume, which begins the fifth Italian edition, contains more than 200 pages devoted to the elementary exposition of general principles, this section having undergone considerable expansion at the hands of the author's son, Vittorio. It treats likewise of hydrogen, the halogens, the elements of the oxygen group (also air and its rare constituents), nitrogen and phosphorus, etc. The very full trade statistics and other special features of the work are retained, but various subjects, such as hydrogen, sulphuric acid, and the utilisation of atmospheric nitrogen for the manufacture of synthetic ammonia, etc., are treated at greater length than formerly. The footnotes, possibly too copious in some cases, remain, and diagrams and figures are interspersed even more lavishly than in the preceding edition; the printer's work is all that could be desired. The second part of the volume on inorganic chemistry is promised before the end of the current year, and will be followed by a new issue of the companion volume on organic chemistry.

The Mongol in our Midst: a Study of Man and his Three Faces. By Dr. F. G. Crookshank. Pp. 128+29 plates. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1924.) 2*s.* 6*d.* net.

DR. CROOKSHANK argues with much skill in favour of his view that in the not uncommon occurrence of Mongoloid characters in Western Europeans, of which the extreme example is the so-called Mongoloid imbecile, there is something more than a fortuitous resemblance to the racial Mongol. He adduces a large number of homologies between these abnormal cases and the Mongol races, emphasising in particular the peculiar method of sitting with the legs in the horizontal position familiar in the statues of Buddha, which seems natural to the Mongoloid imbecile, and maintains that they point to the atavistic character of this peculiarity. Mr. H. Peake has argued in favour of the introduction of a Mongoloid strain in Northern Europe in prehistoric times, and it is by no means impossible that some infiltration of Mongol blood may have followed from the racial invasions of Eastern Europe. Dr. Crookshank, however, presses his theory further and seeks to connect the Mongols with the orang, setting them against the group in which he places other races—with dementia præcox as the corresponding form of mental disease—and the chimpanzee and gorilla. It is this part of his theory which has been most strongly criticised, for, as he shows, it involved the adoption of Klaatsch's theory of two distinct parent types, one for orang and Mongols on one hand, and one for gorilla and negro on the other—a theory which has not found favour among anthropologists generally.

Transactions of the Institution of Chemical Engineers. Vol. 1, 1923. Pp. xv+120. (London: Institution of Chemical Engineers, Abbey House, Westminster, 1924.) n.p.

THE Institution of Chemical Engineers is to be congratulated on its first volume of Transactions, which reaches a high standard both in form and in contents. The volume opens with a brief history of the steps taken to found the Institution, and contains papers read before it. The first paper is a long monograph by T. C. Finlayson on industrial oxygen. In this the various known methods for the manufacture of oxygen are described and analysed both from the technical and economic aspects, and an account of original experiments is given. The results obtained were not capable of industrial application, but the paper was described as valuable in the discussion. A short contribution on absorption towers by M. B. Donald and C. W. Tyson, a study of the conditions of constant rate of flow in filter presses by M. B. Donald and R. D. Hunnemann, an outline of the present knowledge of corrosion by M. B. Donald, and a bibliography of chemical engineering literature (1900–1923) form the rest of the volume. It is evident that these contributions have been

composed in a scientific and practical style, and the volume is evidence of the really good work which the Institution may be expected to do in future in the interests of chemical engineering.

Physische Meereskunde. Von Prof. Dr. Gerhard Schott. (Sammlung Göschen Nr. 112.) Dritte, umgearbeitete Auflage. Pp. 155. (Berlin und Leipzig: Walter de Gruyter und Co., 1924.) 1.25 gold marks.

THIS is a very small book. but the amount of information that it contains is extraordinarily great. The author does not discuss the whole subject from a general point of view so much as give a concise exposition of each section of physical oceanography, together with the methods employed in obtaining the data.

The book is divided into three sections. The first deals with the ocean as a whole; the depth and character of the sea-bottom are discussed, and its general morphology in relation to the land is described. Section 2 deals with the properties of sea-water, and is divided into subsections on the physics and chemistry of sea-water, on the distribution of temperature in the sea, and on the ice found in the sea. The last section describes the various kinds of movement occurring in sea-water. The theory of wave motion in the sea is discussed in a very interesting manner. The last two chapters on the tides and on the ocean currents are rather disjointed, because the facts are first set out by themselves and their explanation is given afterwards in the form of explanatory paragraphs.

Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 3. H. T. Clarke, Editor-in-Chief. Pp. v+104. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 7*s.* 6*d.* net.

VOL. 3 of this series fully attains the high standard reached in the two previous volumes. The preparations described are models of careful work and explicit detail. For the use of students the book is excellent, though the quantities employed in the preparations are somewhat large, and changes in these quantities sometimes imply considerable alteration in the other experimental details, as the reviewer found in the preparation of allyl alcohol (vol. 1, 15-19).

The chief purpose of the series is to place on record certain well-tried and proven methods of preparing intermediate compounds used in research and technical work, and the volumes so far produced justify the work of the contributors. It seems a pity that more contributors have not added to these volumes some of the many methods of preparing products necessary for the prosecution of research which have been improved in their laboratories but are not generally known.

The method of indexing is novel and should prove useful. L. C. N.

Amurath to Amurath. By Gertrude Lowthian Bell. Second edition. Pp. xvii+370+105 plates. (London: Macmillan and Co., Ltd., 1924.) 21*s.* net.

A SECOND edition of Miss Bell's account of her journey from Aleppo to Baghdad, and thence to Konia, is very welcome; for surely "Amurath to Amurath" deserves to rank with the best of travel books. Miss Bell's keen observation, penetrating judgment, and profound archæological knowledge, which are combined with a gift of graphic narrative, are here perhaps at their best. She is equally at home in describing an ancient Mesopotamian site and in recording the gossip of the bazaar. Her thumb-nail sketches of the people she met are vivid and compact with an imaginative insight into the soul of the Eastern races. As this book was first published in 1911, soon after the uprising of the Committee of Union and Progress and the advent to power of the young Turk, its political interest, when read in the light of subsequent events, scarcely need be emphasised.

A Handbook of Telephone Circuit Diagrams: with Explanations. By John M. Heath. Pp. x+279. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 12*s.* 6*d.* net.

To any one who desires to acquire a good practical knowledge of the art of telephony we can recommend this book. In order to get the full benefit from it, however, he should first study a good elementary treatise on the subject. Every telephonist has to spend much time and study in puzzling out the various wiring diagrams of the different units in a telephone system. In this book the circuit diagrams are the predominating feature. They are arranged in a logical and progressive manner, following generally the historical development of the art. Having once understood the diagrams of the component parts, it is easy to understand the wiring diagrams as a whole. The symbols are well chosen and a study of the circuit diagrams will give the necessary complementary knowledge to that given in text-books.

Evolution, Knowledge and Revelation: Being the Hulsean Lectures delivered before the University of Cambridge, 1923–24. By the Rev. Stewart A. McDowall. Pp. xviii+118. (Cambridge: At the University Press, 1924.) 6*s.* net.

THOUGH dealing with problems of religion and philosophy, and leaning entirely to an extreme form of metaphysical idealism, this little book, consisting of four lectures, is thoroughly scientific in spirit and in method. The lectures aim, the author tells us, at establishing a theory of knowledge based on the facts of evolution and in sympathy with the spiritual interpretation of Nature by the best metaphysical systems. Though necessarily slight, the book is never dull.

Economic Geography. By Prof. R. H. Whitbeck and Prof. V. C. Finch. Pp. x+558. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

PROFS. WHITBECK and FINCH'S volume is a well-written text-book on orthodox lines, which result in the field of economic geography being somewhat restricted. The United States and Canada are treated very fully as one economic unit, followed by a summary of Canada. These chapters contain much useful material, but the rest of the world, with the exception of Central and South America, receives too brief a treatment for the book to prove acceptable on the eastern side of the Atlantic. The sketch maps and diagrams are instructive, and there are bibliographical references.

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.*]

International Co-operation in Phenological Research.

THE need for international co-operation in recording the dates of special events in the seasonal development of a few representative species or varieties of native and established cultivated plants will be recognised when the facts are considered, that the time of such events as the opening of leaf and flower buds, the completion of growth, the ripening of fruit, the harvesting of crops, etc., are true expressions, not only of the influence represented by the three important elements of climate, temperature, precipitation and sunshine, but, in addition, that represented by all other elements in the physiographic complex of the environment affecting in any degree the seasonal development of a plant. When it is considered, further, that the correct interpretation of the geographic and economic significance of the average date of the same event, at representative places within the geographic range of the species, is an element of a true index to the bioclimatic character of each place and the immediate region represented, it will be realised that such records are of the greatest importance, especially in connexion with those of temperature and precipitation, in the study of geographic distribution of plants and animals, types of climate, cultivated plants, world agriculture, etc.

While the influence of climate and weather conditions upon native plants and cultivated crops have been noted from the earliest days by individual observers, it is only in the last fifty years that attempts at united efforts, such as with the records of temperature, air pressure, and, above all, rainfall, were sufficiently organised anywhere to form the branch of science designated as "phenology."

Yet its importance to agriculture and horticulture is great and has already proved to be of material commercial value. This is especially the case in the United States through the Department of Agriculture, where it has received great attention under the leadership of Dr. A. D. Hopkins. The same is true, if to a less recognised extent, in the British Isles, Central Europe, Belgium and Holland (under Dr. Bos), the other countries actively carrying on similar work. In Germany, under Hofman and Ihne, it has been carried on unofficially for more than forty years on one systematic plan confined to flowering plants, especially trees and shrubs.

British co-ordination began in 1877 under two distinct organisations. The smaller was carried on in the *Natural History Journal* from 1877 to 1898, as a "Floral Calendar" and "Migrant Table," twenty year averages being obtained. But more important and permanent is the phenological work under the auspices of the Royal Meteorological Society, under the successive leaderships of Rev. T. A. Preston, Mr. Edward Mawley (by whom it was reorganised in 1890), Messrs. Clark and Adames, and the present committee. Flowers, birds, and insects are included in the records, but fourteen of the first form the most essential part.

The results of this work as represented by averages of the essential records have been correlated with the averages of the three most effective climatic elements, temperature, rainfall and sunshine, and thus form a comprehensive interpretation of the various climatic regions and areas of the British Isles and their relation and relative importance to our agriculture and horticulture. They also lend themselves to important geographical correlation with the countries named above, and, not least, with the exhaustive work in the United States. We therefore venture to suggest that the time has come for similar systematic work to become world-wide.

Special mention must be made of the Hopkins' "Bioclimatic Law," worked out for the United States, but through which results obtained in one country can be applied elsewhere, with considerable confidence, if equivalent phenological records are available.

It is for such reasons that the present appeal is made, for co-operation in the establishment of similar work through the Dominions and elsewhere, especially throughout Europe and extra-tropical Asia,[1] whereby accurate records may accumulate as a basis for interpreting the relative influence of the local and regional climate, weather, and seasons on the periodical events in plants and animals, seedtime, and harvest, etc. Our suggestion is that such world-wide inauguration of this work, particularly in extra-tropical countries, will quickly provide data of great scientific and economic value towards the advancement of world agriculture. After the lapse of ten years or so, sufficient data should exist for inter-regional correlation, whereby, under the Bioclimatic Law referred to above, results obtained from similar records elsewhere could be given universal application.

Such correlation is yet in its infancy, but has already been tentatively extended from the United States to Great Britain[2] and Western Europe, although hampered by the divergent character of the records in different countries.

This suggests that, in further development, a more uniform and simplified method is most desirable, including at first a very limited number of common and widely distributed species or varieties[3] of native or cultivated plants and only the more essential events.

Our own method of working is based upon a schedule sent out each year to the observers. No two countries can use identical lists, and each country or province would need its separate organisation. But in selecting the series best covering for the given region the full period of growth and maturity, the inclusion of some identical flowers of widespread range would have great value for such possible correlation. The British list suggests a selection of some of the following as possible for common ground: hazel, dog-rose, snowdrop, blackthorn, horse-chestnut, oxeye daisy, and hawthorn. It may prove desirable to add a few more of widespread range to the lists now in use, such as the first shooting and first unfolding of the basal pinnæ of bracken, flowering of almond or peach, silver birch, locust tree (white acacia): possibly the flowering of some field crop and weeds of cultivation. Suggestions as to any such adapted for observation in other areas would be helpful.

It occurs to us that as a beginning some one official or investigator at each of the more representative meteorological and agricultural stations and other institutions of public service in scientific research, as well as private workers, in each of the principal countries might be specially interested in making consecutive observations. It would require little time and effort to record the dates of the more

[1] Tropical regions present far more complicated problems, yet it seems a pity to exclude them.
[2] Journal of the Washington Academy of Science, 1921, pp. 223-227.
[3] With varieties, the same must be selected for all stations.

important seasonal events of some common plant or plants, such as the opening of the leaf and flower buds on a tree or shrub, observed from the office window, the ripening and harvesting of a crop in an experimental plot or on neighbouring farms, yet such records would serve not only as a matter of personal interest but also, through an interchange of records each season, and ultimately the publication of averages, they would soon furnish a source of information which would be of inestimable value to investigators of the problems of local and world agriculture.

1925 completes the thirty-five years of observations on one system in the British Isles, a period well recognised as of meteorological importance, and with its close it may be advisable to introduce modifications. Therefore we are the more anxious to associate ourselves with any wider developments which may be evolved, and we make an earnest appeal for such co-operation.

The interest manifested by replies to these suggestions from persons in different countries will indicate whether or not further efforts towards the formulation of a uniform plan of records and co-operation will be justified. We ask such to communicate with us.

Copies of our last Report illustrating the work carried on in Great Britain will gladly be sent to indicate its character. Moreover, many readers of NATURE in this country[4] will know individuals and societies whom it would be well to approach, and the names and addresses of such will be most welcome. No doubt there are many solitary workers unaware of what is being done, for, as Dr. Bos has pointed out, no journal of phenology at present exists. The help also of residents in the homeland would be most welcome.

The fact that the work in the British Isles has been under the auspices of the Royal Meteorological Society is to a certain extent accidental. For it concerns a far wider circle than meteorology, particularly botanical, agricultural, ecological, biological, climatic, and geographical interests. For this reason we are acting after consultation with, and approval of, not only the well-known phenologists already named, but also Mr. J. C. F. Fryer, of the Biological Department of the Ministry of Agriculture and Fisheries; Mr. J. Burtt Davy, lately Chief of the Division of Botany and Government Botanist, Union of South Africa; Mr. A. G. Tansley, Prof. E. J. Salisbury and Prof. F. W. Oliver, through whom we have the support of the Ecological Society. We have also the full approval of the Council of our own Society through Capt. C. J. P. Cave, our president, and Mr. R. H. Hooker, a recent president.

Communications may be addressed to J. E. Clark, 41 Downscourt Road, Purley, Surrey, England.

J. EDMUND CLARK,
IVAN D. MARGARY,
RICHARD MARSHALL,
Phenological Committee of the Royal Meteorological Society.

NOTES ON THE BIOCLIMATIC LAW.

THE writer has had the privilege of seeing the original draft of Mr. Clark's letter to NATURE with reference to "international co-operation in phenological observations," and he is heartily in sympathy with the ideas covered in this initial movement towards the extension of the service to world interests in agriculture through observations and research in this relatively unrecognised branch of natural science.

In further reference to the Bioclimatic Law mentioned by Mr. Clark, it may be stated that it was from studies of the relation of latitude and altitude to the difference in time of the emergence of the Hessian Fly, and its attack on wheat sown at given times, that the idea of a natural law was suggested in 1895, and that the development of this law has been based largely on a comprehensive study of the dates of seeding and harvesting winter wheat within the distribution of this crop in the United States;[1] on general and specific and phenological observations and studies in this country, and utilisation of the published records of the comprehensive work in the British Isles and Germany. On account of the meagre or lack of phenological records from other countries, it has been necessary to rely on published climatic, biological, geographical, and agricultural data for the inclusion of most of the other countries of the world in a comprehensive study of the relations of the law to world agriculture and other human interests.

While these additional data have served as important elements in the development of the law and its application to research and practice, it is increasingly apparent that phenological data from the different countries are far more important.

Briefly stated, the Bioclimatic Law is one of effect in response to the laws of causation represented by the sun, the motion of the earth, unequal distribution of land and water, and the varying physiographic features of the continental and insular areas. This law of effect is interpreted as requiring a broad, general, country-wide variation in time and temperature, as related to types of equal phenomena of life and climate, at a unit constant rate per distance in degrees of latitude, poleward and equatorward; longitude, east and west; and feet or metres of altitude above sea-level (as four days of time between the dates of the same phenological event to one degree of latitude, five degrees of longitude (earlier from west to east), and four hundred feet of altitude).

The application of these principles in the study of the geography of life and climate, designated as the science of *Bioclimatics*, is in accordance with the principle of the *variable* and the *constant*, in which the recorded quantity in time, temperature, etc., for a given geographic position is the *variable*, and the corresponding quantity computed for the same position from the unit constant requirements of the law is the *constant*.

The variation of the recorded quantity from its constant represents a *Bioclimatic Index*, or measure, of the intensity of the local and regional influences of the causation complex relative to that determined for a continental or intercontinental base. Thus the bioclimatic index for a number of representative positions within a local or general region will indicate the trend and extent of the variations from the requirement of the law and consequently serve, in connexion with information on the topography and precipitation, as a basis for interpreting the bioclimatic character of the region, as to the type of climate and corresponding life that may be expected to prevail; in other words, indicate the life and climate, or bioclimatic zone, that is represented, which in turn will indicate the kinds of crops that can or cannot be grown, so far as controlled by temperature and precipitation.

Thus if we had, in addition to the already available meteorological data, a long-time series of phenological records from representative positions in the

[4] Incidentally, we would point out that fresh British observers are always welcome. Our appeal through the pages of NATURE two years ago gave us a most satisfactory accession of stations.

[1] Suppl. No. 9, *Mon. Weather Rev.*, U.S. Dept. Agric. Weather Bureau, 1918.

different countries of the world, their bioclimatic zones could be predicted and mapped (so far as maps of topographic surveys are available), as has been demonstrated by a detail map of the bioclimatic zones of the United States and preliminary maps of the thermal zones of the British Isles, Germany, and Australia. A. D. HOPKINS.

Organisation in Chemical Societies.

As one who has some direct knowledge of the affairs of the Chemical Society, I should like to reply to the letter from Dr. M. W. Travers which appeared in NATURE of October 4. Dr. Travers has presented a singularly one-sided statement of the position, for in his endeavour to prove that the societies give an inadequate return for the subscriptions received, he omits essential points which any fair-minded man would take into consideration before giving a verdict on that charge.

In the first place, Dr. Travers criticises adversely the decision to make an extra charge for the Chemical Society's "Annual Reports," since, in his view, students, to whom this publication particularly appeals, will be thereby discouraged from joining the Society. He omits to mention, what is equally relevant, that, for the present, new fellows are not required to pay the entrance fee of 3*l.*—a financial alleviation which has been introduced mainly to meet the case of the young chemist, and ought in fairness to be set against the new charge for the "Annual Reports." The necessity of paying 3*l.* in addition to the first annual subscription has, quite naturally, prevented many students and junior chemists from joining the Society.

Then the Chemical Society's Library, with the upkeep and development of which all the leading chemical organisations are now associated, is put out of count by Dr. Travers, because it is not "in any way comparable with the Patent Office Library." Against this unwarranted and contemptuous reference to the Library of the Chemical Society I should like to put the plain fact that, since the opportunities for using the Library were extended some years ago, the annual number of readers has increased from between two and three thousand to between six and seven thousand, and is rising steadily. Further, the Patent Office Library, however useful to Londoners, cannot serve chemists who reside in the provinces, whereas a large proportion of the books and journals in the Chemical Society Library can be borrowed, either directly or through the post. The extent of the availability of the Chemical Society Library is not generally realised.

As to abstracts, it is, of course, well known that the American publication covers a much wider area than the two sections of the British abstracts combined, but that is not necessarily an unmixed advantage. Against the narrower scope of the British publications, however, it is only right to set the fact that abstracts appear there more promptly than in *Chemical Abstracts*. Some papers, more particularly those from American sources, are reported earlier in *Chemical Abstracts*, but the majority are abstracted first in the British publications. The more prompt appearance of the British abstracts is a valuable feature which deserves to be emphasised.

Those who give time and thought to the affairs of the chemical societies have, I believe, no objection to candid criticism, provided it is just. In connexion with abstracts, for example, the desirability of improvement and co-ordination is recognised, and I would invite Dr. Travers (and any other critics) to submit to us any really *constructive* suggestions, not in the spirit of his letter, but in the spirit of co-operation. As chairman of the Bureau of Abstracts, I guarantee that any such practical suggestions will receive fair consideration. JAMES C. PHILIP.

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Transformations of Elements.

THE theory of allotropy, starting from the supposition that every state of aggregation (phase) of a so-called simple substance (system of one component) is complex, that is, consists of different molecular species, and stating that behaviour as a simple substance is only due to the rapid establishment of equilibrium between these different kinds of molecules (inner equilibrium), has led, when applied to metals, to a theory of electromotive equilibrium. Herein it is assumed that with metals the complexity consists in the existence of atoms, ions (of the same or of different valency) and electrons. These various particles give rise to an inner equilibrium which in the simplest case is represented by the formula:

$$M_s \rightleftarrows M_s^{\nu\cdot} + \nu\Theta_s,$$

in which ν indicates the number of positive charges on the metal ion, and the suffix s that the solid state is being considered.

From this point of view, polarisation occurs if the withdrawal of electrons and the combined ejection of ions, respectively the supply of electrons and the combined deposition of ions, takes place more rapidly than the establishment of the inner equilibrium. If there is no formation of molecules, this can only be due to a too slow course of the reaction mentioned above.[1] By sending a metal rapidly into solution, for example, by means of an electric current, according to these considerations the metallic surface will become impoverished as regards electrons and ions, and the theory shows that in this case the metal will behave electrolytically as a more noble metal, which normally contains a smaller electron- and ion-concentration. Consequently, a base metal temporary can transform superficially into a pseudo-noble state by rapid anodic solution.

Now the question arose if experiments in the same direction, but arranged differently, could possibly lead to wider and deeper disturbances. In connexion with secondary phenomena, such as the discharge of anions, contact with an electrolyte is an important hindrance to creating a powerful disturbance. This difficulty is removed, of course, if, instead of a liquid, a rarefied inactive gas is used. That also, in inactive gases, metals show polarisation phenomena, is found by Gaede and others, but while by their point discharges only small current densities were acting, the disturbance could not be large. It is clear that the best method to obtain a large disturbance is to use the electric arc-flame. For several years I have therefore intended to study different metals, in a vacuum lamp, in the hope that on increasing the current density the disturbance of the metal would become so large, that not only the valency electrons, on leaving their orbits, should be snatched away and thus prevented from falling back, but also the deeper electrons, and perhaps those of the nuclei, whereby, in the latter case, also α-particles could be split off.

Much occupied by other investigations, the experiments mentioned above were delayed. I was greatly interested, therefore, to read, in July last, the communication of Prof. Miethe on the transformation of mercury

[1] See "The Theory of Allotropy," p. 130.

into gold in the mercury lamp of Jaenicke, when burning overcharged. I resolved to return to my proposed experiment, and I did not intend to study mercury but lead. In accordance with this original scheme, I have now carried out some experiments. Peculiar difficulties arise, because lead fuses at 327° C., and also because lead, solidified in a quartz vessel, breaks the vessel if heated again. Notwithstanding this, we succeeded in constructing a satisfactory lead quartz lamp (Fig. 1). The two legs A and B end in two narrow tubes, in which two steel electrodes are cemented with sealing wax. Around these cemented ends two little copper water coolers G and H are inserted, preventing fusion of the sealing wax. Vessel C is the store vessel, into which the pure liquid lead is poured, after which the open end is sealed off. An electric furnace around C keeps the lead liquid. Tube D, which is bent, contains a capillary F and ends in a cock K. The free end of the cock is connected with the mercury diffusion pump.

When a high vacuum is reached, the vessel C containing the lead is heated to redness with the Bunsen burner, with the result that all oxide is dissociated, and that

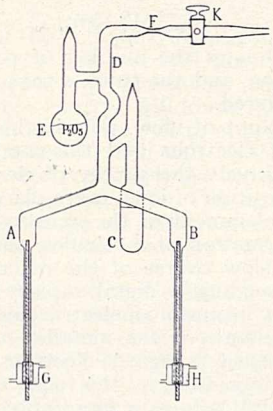

FIG. 1.

the metal, freed from all gases, has a surface as smooth as pure mercury. After closing the cock K and breaking the connexion with the pump, the apparatus is inclined, and the liquid lead is run into the two legs of the lamp. Now the lead is once more heated to redness in the two legs to drive out the gases from the steel electrodes. Many gas bubbles escape now and the apparatus is evacuated once more. After that the lamp is ready, and can be used in the same way as the mercury lamp, with this difference only, that removable radiating coolers cannot be placed around the legs A and B before the lamp is working. At the end, the liquid lead is again brought into the vessel C, which is continuously heated by the little electric furnace at 350°.

Because bismuth is also an element which is to be considered here, and the system lead and bismuth has a eutectic point at about 120°, it was of interest also to try this eutectic composition. We found that this alloy can be used in exactly the same way.

It is clear that the investigation of these lamps is not only of use to show whether transformations of elements can be realised, but also to study the arc spectrum. The lamp here described, like the vacuum mercury lamp, burns at relative low voltage; we are constructing another lead lamp which, like Jaenicke's lamp, burns at higher voltage. We hope to be able to communicate some results shortly.

A. SMITS.

Laboratory of General and Inorganic Chemistry,
University of Amsterdam, September 15.

An Approximation to the Probability Integral.

THE probability integral

$$\Theta(t)=\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$$

can be represented by the simple approximation

$$\frac{6}{\sqrt{\pi}}\cdot\frac{t}{3+t^2}=3\cdot385\frac{t}{3+t^2}=1\tfrac{1}{8}\frac{t}{1+\frac{1}{3}t^2}$$

over such a range ($t<\sqrt{3}$) as to make the approximation useful to the statistician and others whose problems do not require great accuracy.

Since

$$\Theta(t)=\frac{2}{\sqrt{\pi}}\left(t-\frac{t^3}{3}+\frac{t^5}{10}-\frac{t^7}{42}+\ldots\right),$$

and ($t<\sqrt{3}$)

$$\frac{6}{\sqrt{\pi}}\cdot\frac{t}{3+t^2}=\frac{2}{\sqrt{\pi}}\left(t-\frac{t^3}{3}+\frac{t^5}{9}-\frac{t^7}{27}+\ldots\right),$$

$$\Theta(t)=\frac{6}{\sqrt{\pi}}\cdot\frac{t}{3+t^2}-\frac{2}{\sqrt{\pi}}\left(\frac{t^5}{90}-\frac{5t^7}{378}+\ldots\right).$$

For small values of t the approximation is evidently good. Beyond $t=\sqrt{3}$ it clearly fails. But at $t=\sqrt{3}$ the error is within one per cent. At first the approximation is slightly in excess of the function, but the error reaches its maximum near $t=1\cdot2$, vanishes after $t=1\cdot5$, and then becomes negative. As $t=\sqrt{3}$ means more than 3·6 times the probable error, the range of useful approximation is quite considerable.

For some purposes it will be convenient to write

$$t=\sqrt{3}\tan\tfrac{1}{2}\phi,\quad \phi<90°,$$

$$\Theta(t)=\sqrt{\frac{3}{\pi}}\sin\phi=[-0\cdot0100]\sin\phi.$$

Thus for $\Theta(t)=\frac{1}{2}$, $\phi=30°\cdot77$ and $t=0\cdot4766\ldots$ as compared with the true value $\rho=0\cdot4769\ldots$. Further comparison is given in the following table:

ϕ.	t.	t/ρ.	$\sqrt{\frac{3}{\pi}}\sin\phi$.	$\Theta(t)$.	Diff.
60°	1·000	2·097	0·8463	0·8427	+0·0036
69·8	1·208	2·533	0·9171	0·9125	+0·0046
83·1	1·535	3·219	0·9701	0·9701	0·0000
90	1·732	3·632	0·9772	0·9857	−0·0085

Beyond the last point the approximation allows for 23 cases per 1000, while the normal law allows 14. As abnormally large deviations are often in excess of expectation, this is no bad thing. For approximate calculations of this kind it is well to remember that the reciprocal of 2·1 is 0·4762, which is very nearly the value of ρ.

It is evident that

$$\int_0^t\Theta(t)dt=\frac{3}{\sqrt{\pi}}\log_e(1+\tfrac{1}{3}t^2)$$
$$=3\cdot897\log_{10}(1+\tfrac{1}{3}t^2)$$

is a very close approximation over the range $0<t<\sqrt{3}$.

A far closer approximation to the error function has been given by Mr. H. B. C. Darling (*Quart. J. of Math.*, xlix. p. 36), but its form makes it unsuitable for the purely practical purposes here contemplated.

H. C. PLUMMER.

Artillery College, Woolwich, S.E.18,
October 1.

Is *Orchis Fuchsii* (Druce) a Valid Species of Orchidaceæ?

THERE has for some time been going on a controversy among botanists as to whether Linnæus in establishing his species *Orchis maculata* omitted from, or intended to include within, it a very closely related form collected by himself, which has been raised to specific rank by Dr. Claridge Druce as *O. Fuchsii*. The question whether the latter is only a variant of

the former or not appears to depend on whether Linnæus in his diagnosis of *maculata* intended the description of the middle lobe of its trifid labellum to apply to one or both.

On reading the discussion, I was reminded of some observations—of interest perhaps to the disputants—which I made on this orchid in 1922 during a stay near Heathfield in Sussex. The banks of the railway between Mayfield and Heathfield, and of the high road from Brighton through the latter place to Kent, are profusely empurpled in its season with the spotted orchis. Long habit induces me, whenever in the country, to gather specimens of the flowering plants I meet with, for the pastime of discovering any variation from type, especially of orchids, to record the proportion of cross to non-fertilised flowers. I daily brought to my rooms, therefore, handfuls of this orchid.

While on the majority of the plants, gathered from the *same* communities—all to me obviously *maculata*—the lateral segments of the labellum were normal in being larger than the central one, which, though somewhat less in breadth, did not much, if any, exceed them in length, I was nonplussed—as notes and a rough sketch made in my journal at the time indicate—to find in a considerable number that the central lobe of the florets, differing from the figure in Fitch's illustrations (the only botanical work I had with me), was conspicuously longer, very sharp pointed, and, both actually and in comparison with its fellow side-lobes, much narrower than in the others. I believe (without being absolutely certain on the point) that florets with the more normal labellum and those with a long-pointed mid-labellar lobe occurred together on the same spike. As I was then unaware of the controversy I did not make the precise observations I might have done, thinking that the differences were—as I incline still, even if they occur on separate plants only, to believe—merely varietal. *O. Fuchsii* would, in my amateur opinion, appear to be only a variety (if not an oft-recurring sport) of *O. maculata*.

HENRY O. FORBES.

Deanway, Beaconsfield, Bucks.

Regularities in the Spectrum of Ionised Titanium.

THE spectrum of ionised titanium is very interesting, owing to the fact that a large number of chief lines lie between $\lambda=3000$ and $\lambda=4500$, and hence enhanced lines of titanium form a very characteristic feature of the spectrum of the solar chromosphere and the stars. As regards the chromospheric spectrum, lines of Ti^+ at $\lambda=3685$, 3759, 3761 reach a height of 6000 km., and many other lines reach heights exceeding 1500 km., while resonance lines of titanium ($\lambda=5193{\cdot}12$, 5173·92, 5210·59)—following the classification given by Kiess and Kiess—reach heights of 500 km. only. In this respect the behaviour of titanium is parallel to that of calcium, both as regards the ordinary as well as the enhanced lines, though owing to the larger atomic weight, titanium fails to reach the great height of Ca^+, as given by the H and K lines. Also no lines of Ti^+ dominate the spectrum to the same extent as the H and K lines dominate the spectrum of Ca^+.

Recently King has published a very thorough study of the spectrum of titanium in the furnace, and the arc. This has enabled me to study the regularities in the spectrum of Ti^+. The chief lines can be arranged as quartet groups, and the lowest levels are given by three p-terms with the frequency differences 861 and 509. The structure fits in admirably with the rules given by Lande (*Zeitschrift für Physik*, vol. 15); for, according to the displacement rule of Sommerfeld and Kossell, the spectrum of Ti^+ ought to be similar to that of scandium, which has been shown by Catalán to consist of quartets and doublets. The separation of the p-terms, according to Lande, ought to be as 5 : 3, while 860 : 509 = 5 : 2·96. The separations of the d-terms ought to be as 7 : 5 : 3, while we have found them to be 98·40 : 69·46, 45·86 = 7 : 5 : 3·1. The precise value of the ionisation potential of Ti^+ has not yet been obtained, but it seems to be about 13 volts. The ionisation potential of titanium itself has been shown by Kiess to be about 6·8 volts. This is in accordance with the fact that in the spectrum of stars the behaviour of T^+ and Ca^+ are almost parallel—*vide* W. J. S. Lockyer, Mon. Not. Roy. Ast. Soc., vol. 81, who finds that titanium lines are stronger in F5G stars (ϕ-Cassiopeia) than in A2F stars (α-Cygni).

A full account of the work will be published very soon.

NALINI KANTA SUR.

Allahabad,
September 25.

"Evolution at the Crossways."

I MUST protest that from the notice of my book on "Evolution at the Crossways," in NATURE of October 4, no reader can get a correct impression of what my theory really is.

The reviewer makes me speak of "righteous" or "unrighteous" insects, for example. But I have specially guarded myself (p. 11) that the bio-morality which I posit does *not* involve conscious morality or really ethical praise or blame. I speak (only rarely and in a general way) of "biologically" righteous and "biologically" unrighteous conduct, *i.e.* in respect of the interdependence of life, of mutual relations. More commonly, however, I use instead the terms "cross-feeding" and "in-feeding" species. My thesis is that "Nature abhors perpetual in-feeding"—the analogue of Darwin's aphorism regarding "in-breeding." The difficulties the reviewer has with my theory are more apparent than real. Have his sharks or echinoderms anything to boast of? Have the molluscs, numerous though they be? They reached their highest development in the massive and almost mindless cuttle-fish. Most of these are indeed predatory and carnivorous. What has it led them to?

The critic's "agriculture" argument is beside the point, unless he intends to be more anthropomorphic than I am. Surely species may be retrogressive, though still of some use to man.

H. REINHEIMER.

103 King Charles' Road,
Surbiton, Surrey,
October 9.

MR. REINHEIMER may justly claim that only from his words can a reader get a correct impression of the theory. On page 12, we read: "Everything abnormal and pathological is due to biologically unrighteous, *i.e.* fundamentally predatory behaviour. Although predaceous species may apparently, and for a time, live quite well, yet their temporary success is at the expense of permanent survival." On p. 186, "All predaceous animals are on the road to ugliness." On p. 87, "The wages of biological sin are: deformity, inferiority, disease, degeneration, death."

There are no apparent difficulties with Mr. Reinheimer's theory. Sharks and echinoderms may "boast" of having been biological sinners and "in-feeders" since Silurian times without incurring any of the five penalties of p. 87. The brain of the cuttle-fish is not less developed than that of herbivorous molluscs, The inferiority of eagles and whales is not self-evident. nor the deformity of cats and sea-birds, nor the ugliness of mackerel and king-fishers. G. P. B

The Glow of Phosphorus.[1]

By the Right Hon. LORD RAYLEIGH, F.R.S.

THE discovery of phosphorus was one of those which is associated with the transitional period when magic and science flourished to some extent side by side, and when the borderline between them was not very well defined. The discovery seems to have been made by the alchemist Brand, of Hamburg. But in those days scientific discoveries were often cherished as valuable secrets, not so much for their commercial value as for the sense of superior knowledge and power which their exclusive possession was supposed to give. Scientific secrets are sometimes jealously guarded now, but not for this reason. When reticence is observed, it is for the less romantic motive of commercial advantage. In the absence of this motive, the scientific men of to-day tell all they know, and tell it without delay.

The subject of phosphorus emerged into daylight in 1678, when Kunkel, who had learnt the secret by word of mouth, made it public. In 1780 the Hon. Robert Boyle deposited a paper on the same subject with the Royal Society. He had worked it out anew, without more than the hint that phosphorus came from an animal source.

It was a long time before the nature of the luminosity of phosphorus was finally settled. The early investigators not unnaturally classed it with the substances which become luminous by exposure to light, such as impure calcium sulphide. This notion survives in the word "phosphorescence," which is after all purely descriptive of the property of giving light. Now, however, the word is usually reserved for the cases like calcium sulphide. Phosphorus is not commonly spoken of as phosphorescent; its luminosity, as every one now knows, is due to slow combustion in the oxygen of the air. It took a long time to prove this, and the question was still in a measure open down to the year 1874. The doubt arose partly from the extremely small quantity of oxygen necessary to make the phosphorus visibly luminous. Accidental leakages may thus confuse the question. Another puzzling circumstance was that when oxygen was substituted for air the glow was extinguished. This can be shown by means of a large flask containing phosphorus dissolved in olive oil. Though the flask may be full of oxygen, the phosphorus is quite dark. When, however, some of the oxygen is removed by means of an air-pump, the phosphorus suddenly blazes out at a lowered oxygen pressure. The same result may be shown by substituting air for oxygen.

This is not the only peculiar thing about the behaviour of glowing phosphorus. When a piece of cotton wool moistened with bisulphide of carbon is held above a dish containing an oily solution of phosphorus, so that the vapour can stream down from it on to the glowing surface, the vapour has an almost magical effect. It stops the phosphorus glowing altogether. In a little time, the small quantity of vapour gets dissipated, and the phosphorus glows again.

Bisulphide of carbon is only one example of many vapours which will behave in this way. Ammonia, camphor, ethylene, turpentine, and essential oils generally, will do the same thing, though they vary widely as to their effectiveness. The majority of permanent gases have little effect in this way, though I am not prepared to say what they might do at high pressure.

It will probably be admitted on consideration that the action of oxygen is not essentially different from that of the other inhibiting substances. As will be explained shortly, the action occurs between oxygen and phosphorus vapour. A little oxygen is necessary to unite with the vapour as it comes away from the phosphorus surface, but the density that is of any use in this way is very small. If, for example, we have a millimetre of oxygen pressure, there will be in the gas space many oxygen molecules for one phosphorus molecule, and a further increase can scarcely promote the combustion. The action of a great excess of oxygen, as when we admit it up to atmospheric pressure, must be something quite different. There is therefore no real paradox in the quenching by an excess of oxygen. Perhaps this analogy may help to explain the action: A man cannot live without water; if he does not get it he will die of thirst; yet if he swallows too much he may be drowned. The water acts in quite different ways in the two cases, and so does oxygen in contact with phosphorus.

Another very strange thing happens when phosphorus is used to get rid of the last traces of oxygen in gas analysis. Suppose that we start with air in a confined space, and put a piece of phosphorus into it. At first the light is confined to the surface, but as the oxygen approaches exhaustion, the light is seen to become diffused throughout the volume of the vessel. It is easy to understand why this happens. Phosphorus is appreciably volatile at the ordinary temperature. When the surrounding oxygen is abundant it snaps up the phosphorus vapour at once, before it can diffuse away from the surface. But when oxygen becomes scarce the phosphorus has the chance to get some distance before this happens. This much is easy to understand. But if we look closely we see that the glow is not steady, but shows moving clouds of luminosity, most curious to watch. Any one can readily try this experiment. Nothing more is required than a piece of phosphorus stuck on a wire and introduced into a bottle standing inverted with its neck under water.

My own work on the subject started from this experiment, which I tried to develop into something more definite than clouds of vague outline moving in an ill-defined path. Fig. 1 shows an attempt in this

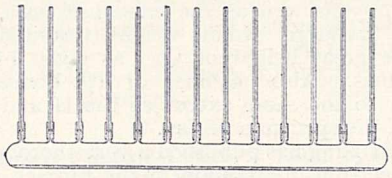

FIG. 1.

direction which had some success. The idea was to constrain the luminosity to move in one direction only. The horizontal tube has a layer of phosphorus lying along the bottom. The long narrow vertical tubes allow air to leak in slowly. When the oxygen originally in the tube is nearly exhausted, luminous pulses are

[1] Discourse delivered at the Royal Institution on Friday, June 6.

seen to spring into existence at the side openings, to divide, and to travel along the tube. Usually this happens predominantly at one or two particular places. Pulses travelling along the tube in opposite directions kill one another when they meet.

This arrangement was set up in a dark room, and watched from time to time. After the lapse of a week or more a change was noticed. Although nothing had

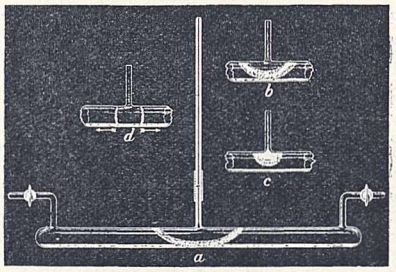

FIG. 2.

been touched, the movements were less lively, and the light had become stationary in places. Finally, all movement ceased.

What could be the explanation of this? The phosphorus had originally been melted into the tube under water, for safety, and the water was, so far as possible, poured off. But, of course, it could not be got rid of completely in that way. The oxides of phosphorus produced by the combustion are greedy of water, and thus had gradually dried the tube. On adding water the movements began again.

The next illustration (Fig. 2) shows a similar tube, with only one capillary entrance at the middle. It was dried out on the mercury pump in the first instance, and filled with nitrogen. A perfectly steady cloud of luminosity is seen when atmospheric oxygen begins to mingle with phosphorus vapour; *a*, *b* and *c* show successive stages as the oxygen influx is increased. If a drop or two of water is added a succession of luminous pulses starts at the side entrance, divides, and travels in opposite directions along the tube (Fig. 2, *d*).

Why does the luminosity move when there is water, and remain steady when there is none? It is evident that the travelling pulses represent the propagation of a wave of chemical action along the tube. There is a mixture of oxygen and phosphorus-vapour ready to unite. It does not at once do so, but chemical union is determined by the passage of the wave, just as in the firing of a train of gunpowder. Nothing of this kind seems, however, to happen in the absence of water. The water holds up the combustion.

Now that matters have been brought to this point, we may recall the experiment in which phosphorus was prevented from glowing by the presence of bisulphide of carbon vapour. Water, it is evident, acts like the other inhibiting substances, but less powerfully. This naturally suggests that we might get the travelling pulses on a more impressive scale by using a more powerful inhibitor than water. It is not desirable to have too powerful an inhibition, however, and I have found that camphor succeeds as well as anything. If a long horizontal glass tube with a mixture of camphor and phosphorus lying on the bottom is exhausted with an air pump, and air is allowed slowly to leak into it through a fine adjustment valve at one end, bright luminous flashes pass down the tube at short intervals. The camphor vapour holds up the combustion until enough air has leaked in to make a mixture of favourable composition, the combustion starts, and the wave is propagated. The period evidently depends on how strong is the inhibiting action. Ammonia is a convenient inhibitor for illustrating this, for its action may be made as powerful as is desired by using a more concentrated solution. The period of the flashes is increased accordingly. The moving clouds of luminosity observed when the absorption of oxygen by phosphorus is nearly complete, are thus linked up quite naturally with the existence of inhibiting substances.

Another series of experiments bring out a further unification of the same kind. They began with the repetition of an interesting observation by L. and E. Bloch, which showed that if some phosphorus was placed in a glass tube, it was possible to blow the glow away from it by a blast of air, and maintain it at a distance downstream. In this form the experiment is rather difficult of control, sometimes succeeding and sometimes failing, for no very apparent reason; but I found it ultimately to be a matter of temperature, a few degrees making the whole difference. Fig. 3 shows the arrangements made by me to bring this under satisfactory control. The phosphorus is a thin flat strip, cast into a suitable recess in the side of a water tank; thus its temperature cannot differ much from that of the water. The latter can be varied at pleasure by the use of ice or warm water. A flat sheet of glass is held at a distance of a millimetre or two parallel to the phosphorus slab, and the air flows between the two, being confined by suitable packing strips at the sides. The channel is prolonged downstream of the phosphorus, and is made suddenly deeper about two inches down.

The accompanying photographs (Fig. 4) illustrate the effects obtained. No. I shows how the phosphorus surface looks without any blast. V shows the glow blown right off, and maintaining itself downstream, where the channel is deepened. The dotted line (inked in on the photograph) shows the position of the phosphorus slab, which is quite dark. This is essentially the Blochs' original experiment. Interesting as it

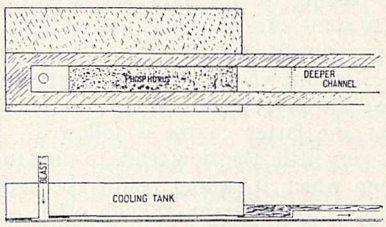

FIG. 3.

is, however, it by no means exhausts what we can learn with the arrangement described.

The effect of changes of temperature was examined, adjusting the blast in each case so that the glow was blown half-way down the phosphorus strip. The velocity of blast necessary to do this was found to diminish enormously as the temperature was reduced. Thus in cooling from room temperature to near the freezing-point, the velocity diminished a thousand times. I next tried altering the oxygen content, and

found to my astonishment that enriching the air with oxygen had the same effect as cooling, and diminished the necessary velocity of blast in an equally striking degree. In both these cases the ultimate result, when the velocity had been reduced to something of the order of 1 cm. per second, was to make the glow flickering and uncertain of maintenance. On cooling a little more, or adding a little more oxygen, it went out altogether.

Now we must remember a fact, often enough insisted upon nowadays, that motion is relative. We have thought so far of the blast acting on the stationary cloud of luminosity, but we might equally regard the cloud of luminosity as propagating itself in the reversed direction through still air. When the air is much enriched with oxygen the necessary blast is gentle—

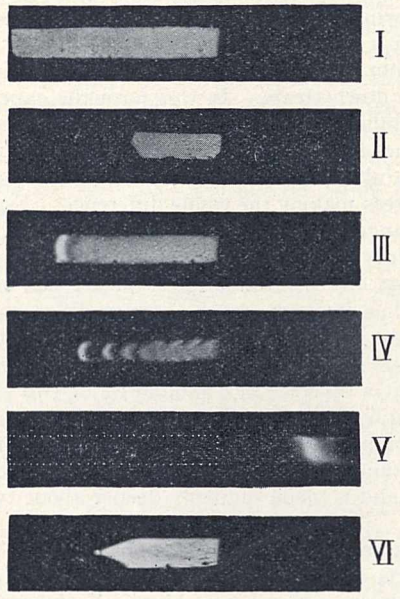

FIG. 4.

in other words, the propagation is slow. It appears then that *extinction is the limiting case of slow propagation*. If we can trace the cause of slow propagation the cause of extinction will not be far to seek.

Before passing to this, however, attention may be directed to some curious effects met with in the course of these experiments on the blast. The same sequence of changes occurs whether we reduce the temperature or increase the oxygen content. Suppose, for definiteness, that the latter course is followed. When the oxygen is very little, the glow tends to cling to particular spots, from which it cannot readily be detached. II shows this to some extent, though other experiments were made in which it was much more striking. On close examination it appeared that these special spots were depressions in the phosphorus surface, where there was partial shelter from the blast. At these places the glow started, and when once started, it infected the gas downstream of it, and made the blowing away impossible. VI shows this very clearly. In this case a hole was made intentionally.

As the oxygen content is increased a bright luminous head develops, followed by a darker space, and then uniform luminosity (III). This bright head no doubt represents the combustion of the stock of phosphorus vapour accumulated as the blast passes over the dark surface.

The next stage, IV, is observed when the blast is so rich in oxygen that extinction is near. A succession of bright heads separated by dark spaces has now developed. This photograph was given four hours' exposure, and was not easily obtained: for some movement of the luminous heads is difficult to avoid during so long a time. The heads were seen quite regularly distributed along the column. The confusion on the right-hand side is due to unavoidable shifts.

The question arises as to why this propagation should occur at all, and why it should be slower when excess of oxygen is present. In the analogy of a train of gunpowder there is no doubt that propagation occurs primarily because each layer that has begun burning heats up the next layer, and causes it to burn too. In the case of phosphorus this explanation is scarcely tenable, because the phosphorus vapour present is only a very small fraction of the atmosphere in which it is contained, and it can be calculated that it cannot yield enough heat to raise the temperature more than a degree or two, which would not be enough.

We must look for some other way in which the action in one layer can help the action in the next; and the suggestion I make is that the action is of the kind called catalytic. It is true that this explanation is incomplete and in a measure speculative. On the other hand, it covers many facts otherwise very hard to co-ordinate. One of the most striking peculiarities of catalytic actions is the facility with which the catalyst is *poisoned*. The exact condition of a surface capable of producing this effect is a very critical thing, and I believe that when the glow of phosphorus is inhibited, it simply means that the particles of phosphoric oxide, or other product of combustion, are spoilt, or *poisoned* by the condensation of molecules of the inhibiting substances upon them; and that this prevents them from assisting the propagation. It is noteworthy that most of the inhibiting substances are easily condensable vapours, such as would be likely enough to act in this way. Oxygen is an exception, but it must be noticed, first, that oxygen will only act when moist; and, secondly, it has to be present in enormous excess—about 20,000 molecules of oxygen for one of phosphorus vapour—before it can quench the glow. Inhibitors like ammonia doubtless act by definite chemical union with phosphoric oxide.

Lastly, the view here explained requires us to suppose that the combination is always breaking out sporadically at isolated centres, though in the presence of an inhibitor it fails to propagate itself. I have recently been able to prove directly that this does in fact happen when oxygen is the inhibitor. When the gas-pressure was lowered the phosphorus glowed; but when it was raised again the phosphorus went out abruptly, like a candle blown out. Nevertheless, under the latter condition, it was found by observations lasting over several weeks, that a slow absorption was going on all the time, and that this action occurred between oxygen and the *vapour* of phosphorus.

This whole research has been rather off the main stream of scientific inquiry at the present time; but it shows that there is still a fascinating field for research about phenomena which have been familiar for centuries.

The Malaria Treatment of General Paralysis.

By Prof. WARRINGTON YORKE, M.D.

UNTIL recently the outlook for patients suffering from the disease known as general paralysis of the insane was practically hopeless. For many years, however, it has been known that the symptoms sometimes exhibited remarkable remissions, the delusions and other mental disturbances subsided or even disappeared for a time, whilst the physical condition underwent a similar improvement. It had been further observed that these remissions were often associated with some intercurrent disease, and attempts were made to induce them artificially by such measures as the production of abscesses or injection of bacterial toxins. The improvement was, however, only transient; sooner or later the mental symptoms reappeared, the patients returned to the asylum, and the disease pursued its relentless course to a fatal termination. In 1919 Wagner v. Jauregg of Vienna, as the result of many years' observation of general paralysis, concluded that possibly it was the rise of temperature, which accompanied the intercurrent disease, abscess formation, or toxin inoculation, that was in some way responsible for the improvement produced in the nervous condition. With the view of testing this hypothesis, he cast round for an infection which could safely be administered to the patients and could, after it had run the necessary course, be readily controlled by the administration of drugs. Two diseases occurred to him, namely, malaria and relapsing fever; and after preliminary trials it was found that the former was the more satisfactory. Wagner v. Jauregg therefore proceeded to infect a long series of general paralytics with malaria, and during the years 1920–21 published results of a most promising nature.

It was the publication of these papers that induced Dr. Clark, the Medical Superintendent of the County Mental Hospital at Whittingham, to test the treatment at his institution; and in July 1922 a number of general paralytics were infected by inoculation of blood from patients who had contracted malaria in the tropics and had come to the hospital of the Liverpool School of Tropical Medicine for treatment. These general paralytics in due course developed typical malaria, and from them other paralytics were inoculated, and so on, the malaria strain being preserved by regular passage from one paralytic to another. Later, the work was commenced at the other mental hospitals in the neighbourhoods, namely, Rainhill, Winwick, Belfast, and Chester.

For various reasons it was decided in a number of instances to modify the mode of infecting the patient, and, instead of producing the disease by the inoculation of malaria blood, to do so by Nature's method; *i.e.* by the bite of infective mosquitoes. The mosquitoes used were two commonly found in Great Britain, namely, *Anopheles maculipennis* and *Anopheles bifurcatus*, and for a constant supply of the former we are greatly indebted to Mr. Rees Wright, of the Department of Zoology, University College, Bangor, who during the winter collected the hibernating females in farm buildings in Carnarvonshire.

Up to April 1924, at the various institutions mentioned and at the Royal Infirmary in Liverpool, 139 cases of general paralysis had been infected with malaria, 98 by the method of direct inoculation of infective blood withdrawn from malaria patients, and 41 by the bites of infective Anopheles. A sufficient time has now elapsed to enable a judgment to be formed regarding the effect of the malaria treatment in respect of 84 of these patients. Summarising the opinion of the medical experts at the mental hospitals, we find that of the 84 patients, fourteen (16·6 per cent.) have died, most of them immediately, or shortly after the completion of the course of malaria treatment; although all these cases had been treated with quinine before death, and parasites had disappeared from the blood, nevertheless it is impossible to affirm that in none of them was death accelerated by the malaria. No noticeable change in mental or physical condition has been observed in twenty (23·8 per cent.); with regard to these cases, however, it is to be borne in mind, as the mental hospital doctors have frequently pointed out, that in the ordinary course of events many of them would now be dead. In ten (11·9 per cent.) there is definite physical improvement but no change in the mental condition. In seventeen (20·2 per cent.) there is great physical and distinct mental improvement. Finally, in twenty-three (27·4 per cent.) the mental and physical improvement has been so great that the patients have been, or are about to be, discharged from the mental hospitals.

It is to be noted that in a number of the cases the improvement has been maintained for many months —in some for so long as a year—and that quite a number are back at their old occupations. As time goes on, it may be found possible to discharge still others of these 84 cases, for, as Wagner v. Jauregg writes: "The maximum of the improvement does not manifest itself at once at the end of the period of fever, but does later. On the contrary, the improvement continues often for a long period, so that in many cases the result seemed to be an incomplete one where later, however, a complete remission came to pass."

Whether the improvement is temporary or permanent, time alone can decide, but the results already achieved can only be regarded as remarkable, when it is realised that no patient suffering from general paralysis had previously been discharged from the mental hospitals in question.

A number of hypotheses have been advanced to explain the mechanism whereby the one disease produces a beneficial action on the other disease; but as none of these hypotheses are based on any substantial foundation, nothing is to be gained by discussing them here.

As might be expected, work of this nature has enabled us to observe malaria in exceptionally favourable circumstances, and as a consequence much has been learned regarding this disease, and many hitherto unsolved problems have been answered. From this point of view the natural infections, *i.e.* those produced by the bites of infective Anopheline mosquitoes, have been especially valuable. They have enabled us to prove beyond all doubt that the three common malaria parasites are all true species and not merely different

stages of the same parasite, as has been so long maintained by Laveran and numerous other observers of the French school. The incubation period of simple tertian malaria—that is, the period which elapses between the bite of an infective mosquito and the development of symptoms and the appearance of parasites in the peripheral blood—has been shown to vary between 9 and 22 days; and much has been learned regarding the clinical course of the disease.

In striking contrast to the cases of malaria which occurred in such enormous numbers during the War, and those with which one has to deal in the ordinary practice of tropical medicine, the general paralytics were readily cured of their induced malaria by a three-days course of quinine, and relapses were remarkably rare. Why this should be so is a question of no mere academic interest, but one of great practical importance and one to which my colleague, Dr. Scott Macfie, and I devoted much thought and work. As the result of a most careful analysis of all the facts available, the conclusion was reached that the remarkable susceptibility to treatment exhibited by the cases of induced malaria is bound up with the fact that in these cases one is concerned with the early treatment of the disease, or, in other words, with the treatment of primary infections.

In our opinion the train of events in the treatment of malaria is as follows: quinine given to a patient whose blood contains numerous malaria parasites invariably destroys—probably indirectly, *i.e.* after it has been changed in some manner by the human body—large numbers, but not all, of the parasites, and by this means sets free a considerable quantity of soluble antigen. The antigen provokes, by stimulation of the host's tissues, the formation of immune-body. The immune-body, if sufficient in amount, destroys the remaining parasites, thus resulting in sterilisation of the infection and in the cure of the patient. When, for any reason, the host is unable to produce immune-body in sufficient amount, the infection is not sterilised and a relapse occurs. We surmise that certain individuals are unable to produce a sufficiency of immune-body to sterilise the malaria infection, possibly owing to inadequate treatment at the time of the first attack, possibly owing to ill-health at the time of infection and treatment, or possibly owing to a personal idiosyncrasy. Whatever be the cause, these are the patients who develop into chronic relapse cases of malaria; such patients can no longer be cured by quinine, not because the parasites they harbour are quinine resistant, but because, owing to a defective formation of immune-body at the time of the initial attack and treatment, the parasites have not been completely destroyed and have gradually acquired an immune-body resistance. If this view be correct, it indicates the paramount importance of adequate quinine treatment at the time of the initial attack of malaria; a course of treatment which suffices to sterilise the primary malaria infection fails to prevent the occurrence of relapses when administered to a case of some standing, and this explains the complete lack of success which followed the most drastic efforts to sterilise the infection in the patients invalided with malaria to Great Britain during the War.

Whether the daily taking of quinine will protect from malaria those living in the Tropics, and subject to the bites of infected mosquitoes, is naturally a question of the greatest importance. Notwithstanding the enormous literature bearing on the subject, no precise information has hitherto been obtained, mainly owing to the great practical difficulties which surround any attempt to make observations from which it would be possible to draw conclusions free from very obvious fallacies. The present investigation has, however, provided the answer to this important question. Our observations showed that the administration of quinine before a person is bitten by an infected mosquito is useless, and that the drug has little if any action on the sporozoites injected by the mosquito. In order to prevent the malaria from developing, the administration of the drug must be continued for at least ten days after the feed of the infective mosquitoes; the daily dose of quinine given has but little influence apart from the fact that, with very large doses (30 grains), the period for which the drug has to be given to prevent development of the infection is a little shortened.

Obituary.

Dr. W. B. Hemsley, F.R.S.

WILLIAM BOTTING HEMSLEY, whose death, in his eighty-first year, took place at Broadstairs on October 7, was born at East Hoathly, Sussex, on December 29, 1843. A member of a family which had a long and honourable connexion with horticulture, Hemsley's knowledge of plants began with his knowledge of the alphabet. Being a somewhat delicate child he had to be educated privately, and before his education had been completed, in order to lead, so far as possible, an out-of-door life, he began his training as a gardener in his father's establishment. Already his taste for botanical pursuits was so marked that, as soon as his training had been completed, he entered Kew as a young gardener in 1860, when in his seventeenth year.

Before the period of two years to which the service of a young gardener at Kew is normally limited, Hemsley's remarkable botanical aptitude had so impressed both the Curator and the Director that he was transferred from the garden to the herbarium. Here young Hemsley's capacity attracted the attention of Mr. G. Bentham, who was then at work on his great "Flora Australiensis," in the preface to the first volume of which reference is made to Hemsley's services. While a temporary technical assistant in the herbarium, Hemsley gave all his spare time to general botanical studies; in 1863 he gained a first prize in botany, awarded by the Royal Society of Arts. In 1865 a vacancy occurred in the permanent herbarium staff, and Hemsley was selected to fill it. But Hemsley's physique could not stand the strain to which the enthusiasm and assiduity with which he performed the duties of Herbarium Clerk subjected it. In 1867 a complete breakdown in health compelled Hemsley, to the regret of his superior officers, to relinquish his clerkship and retire to Sussex. Here, in spite of his illness, Hemsley devoted himself to mastering Latin,

German, and French, and continued his botanical pursuits, the results of which were embodied in a "Handbook of Hardy Trees, Shrubs and Herbaceous Plants," still highly esteemed by gardeners, and in an "Outline of the Flora of Sussex," prized by local botanists. So high was the standard Hemsley had set himself and had attained, that in 1875 the Linnean Society elected him one of its botanical associates.

By 1874, Hemsley's health, though still indifferent, justified his return to Kew as an independent worker. During the next nine years he was engaged principally on the task of elaborating the phanerogamic material obtained during the cruise of the *Challenger*, and of describing the botanical collections of Messrs. Salvin and Godman. The *Challenger* report was published in 1885, and secured for Hemsley the position of a recognised authority on insular floras. The botanical work done on behalf of Salvin and Godman was published in the five botanical volumes of their great "Biologia Centrali-Americana," issued at intervals during 1879–1888; the extraordinary value of this Mexican flora was recognised, so soon as it was completed, by Hemsley's election to the Royal Society in 1889.

Meanwhile Hemsley's health had, happily, become completely restored, and in 1883 he once more was able to join the permanent staff of the herbarium at Kew as assistant for India. In 1890, when Prof. D. Oliver was succeeded by Mr. J. G. Baker as Keeper of the Herbarium and Library, Hemsley was appointed a principal assistant in succession to Mr. Baker, and in 1899, when the latter retired from the public service, Hemsley again succeeded Baker, and served as Keeper of the Herbarium and Library at Kew until his own retirement, at sixty-five, on December 28, 1908. While assistant for India and principal assistant, Hemsley was able to prepare his invaluable work on the flora of China, which occupies three entire volumes of the Linnean Society's Journal. During this period, too, he collaborated with Dr. J. E. T. Aitchison in working out the botanical results of the Afghan Boundary Commission, with Sir Henry Collett in doing the same for the Shan Plateau, and with Mr. H. H. W. Pearson in writing a valuable "Flora of High Asia." He was also the author of many smaller, but always important, botanical contributions, mainly of a systematic character. He took a share, with other members of the Kew staff, in the preparation of the "Flora of Tropical Africa," and assisted Sir Joseph Hooker, after his retirement in 1885, in connexion with the *Botanical Magazine*, which Sir Joseph continued to edit after he had ceased to be Director of Kew.

As Keeper of the Herbarium, Hemsley found his time very fully occupied with official duties, and although many minor contributions to botanical literature were still made by him, he wisely avoided undertaking any task so formidable as those accomplished in his earlier years of active work. After his retirement Hemsley continued this policy for another reason. He did not care to undertake a task he might not have strength to complete. His work on the matters he took up remained, however, as excellent as ever, and was continued until failing physical powers necessitated his seeking a home in a climate more bracing than that of the Thames Valley.

Hemsley's labours were appreciated as highly in other countries as in his own. His contribution to the "Biologia Centrali-Americana" brought him honorary membership of the Natural History Society of Mexico; his knowledge of insular floras brought him honorary membership of the Royal Society of New South Wales, and of the New Zealand Institute, and corresponding membership of the German Botanical Society. His services to garden-lovers brought him honorary membership of the Royal Horticultural Society and the award of its Victoria Medal of Honour. In 1896 the Linnean Society accorded him, at his own request, transfer from associateship to fellowship, and in 1918 the University of Aberdeen conferred on him the honorary degree of LL.D.

The courtesy and consideration which made collaboration with Hemsley as a botanical author as pleasant as it was profitable to those thus privileged, made the relationship between himself as Keeper and his colleagues in the Herbarium equally cordial. Not they alone, but all who ever came in contact with Hemsley will treasure the memory of one whom they esteemed for a kindness as genuine as his sincerity, for a knowledge as remarkable as his modesty.

LORD ABERCROMBY.

ARCHÆOLOGICAL circles in Scotland have lost one of their most distinguished figures by the death of Lord Abercromby, which took place at Edinburgh on October 7 in his eighty-third year.

John, fifth baron Abercromby of Aboukir and Tullibody, was born on January 15, 1841. He was a great-grandson of General Sir Ralph Abercromby, who died from wounds at the battle of Alexandria in 1801, and whose widow was created a baroness. Lord Abercromby succeeded to the title on the death of his brother in 1917. He was educated at Harrow, and for some years held a commission in the Rifle Brigade. After his retirement he took up the study of philology, folklore, and archæology. His publications were not numerous, but they were characterised by accuracy, scholarship, and judgment. Although not all of his conclusions have found acceptance, some of his views, especially those relating to the origin and distribution of Bronze Age types of pottery, have had a profound and widespread influence on the trend of archæological thought. One of the earliest of his publications was "A Trip through the Eastern Caucasus." Better known was his "Pre- and Proto-Historic Finns," in which he traced the history of the Eastern and Western Finns from neolithic times to the Middle Ages, analysed their religious beliefs and folklore, and translated their traditional magic songs. This valuable piece of work was recognised by election as an honorary member of the Finnish Archæological Society and the Finno-Ougrian Society of Helsingfors. His most important work, however, was his "Bronze Age Pottery of Great Britain and Ireland," which appeared in 1912; this was a gathering together and elaboration of the views which he had expressed in various scientific periodicals in the preceding ten years or more. A further notable contribution to the study of prehistoric ceramics appeared in the Journal of the Royal Anthropological Institute for 1914 under the title "The Prehistoric Pottery of the Canary Islands and its Makers."

Lord Abercromby was a fellow of the Royal Society of Edinburgh and an hon. LL.D. of the University of Edinburgh. He was a vice-president of the Folk-lore Society and formerly president of the Society of Antiquaries of Scotland. In 1921 he presided over Section H (Anthropology) of the British Association at the Edinburgh meeting, and when, in the following year, a local branch of the Royal Anthropological Institute was formed at Edinburgh, he was unanimously elected the first president. His tact and charm of manner, his never-failing courtesy to all, and his assiduous attention to the duties of the offices he held, notwithstanding failing health, won the affection and respect of all with whom he came into contact. As Lord Abercromby leaves no heirs male, the title now becomes extinct.

THE death is announced on August 4 last of Dr. Santiago Roth, head of the department of palæontology in the Museum of La Plata, Argentina. Dr. Roth was born in Switzerland and emigrated to Argentina nearly half a century ago, where he became especially skilled in collecting fossil skeletons of mammals from the pampas. He sold many fine specimens to the museums of Zurich and Geneva, and some also to the Zoological Museum of Copenhagen. When the Museum of La Plata was founded, he was employed by the late Dr. F. P. Moreno to collect similar pampean skeletons for that institution, and he was soon appointed to take charge of the fossils. Dr. Roth added much to our knowledge of the pampean formations, which he studied extensively and in great detail, and he also described many of the mammalian remains.

WE regret to announce the following deaths:

Dr. Edouard G. Deville, I.S.O., Director-General of Surveys in the Canadian Department of the Interior, and author of "Astronomic and Geodetic Calculations" and "Photographic Surveying," on September 21, aged seventy-three.

Dr. E. O. Hovey, curator of the Department of Geology and Invertebrate Paleontology of the American Museum of Natural History, on September 27, from a stroke received in his office on the preceding day, aged sixty-two.

Dr. C. W. Moulton, professor of chemistry since 1894 at Vassar College, New York, on September 13, aged sixty-five.

Dr. J. M. Schaeberle, formerly at the Lick Observatory, and author of a number of papers on astronomical subjects, aged seventy-one.

Current Topics and Events

THE Everest Expedition of 1924 reported to a joint meeting of the Royal Geographical Society and the Alpine Club before a distinguished assembly in the Albert Hall on October 17. Earlier in the day a memorial service for Mallory and Irvine was held in St. Paul's Cathedral. Pioneers like Drake and Livingstone, these two perished, as did Scott and Shackleton, in an attempt to go one step beyond the bounds hitherto set to human endeavour, and their names in their simplest form will be treasured in the national memory. Both were Cheshire men, and the Bishop of Chester embodied the spirit of the impressive service under the famous Cathedral dome in an address which showed how the two mountaineers, now at rest in the most magnificent cenotaph in the world, were great climbers because they were great men full of courage, unselfishness and cheerfulness, men who had attained to great spiritual heights, men who had risked life itself in the service of others. Odell, who was in support, was climbing to Camp VI. on June 8 by a circuitous route. He discovered fossils in a band of limestone, and found himself enveloped in mist with clear sky above. By a mere chance he climbed a crag and emerged into a sudden temporary clearing of the mist to a vision of the summit ridge and peak of Everest. Far away on a snow slope near the base of the final pyramid he saw two figures climbing slowly towards their goal, one reaching out to help the other, then the mist fell again. The time was 12.50, and Mallory and Irvine were three hours late on their time schedule, yet they were pressing on. The chances are that they were speeding to the accomplishment of the little bit more which meant so much. Odell believes they got to the summit and were benighted on the return journey. *Sic itur ad astra.* The sure record stands that Mallory and Irvine climbed to 28,230 feet with the help of oxygen. On another attempt, Norton and Somervell reached 28,130 feet without oxygen, and this presages a future success by a similar effort which will probably be made in 1926. Other records were Odell's three ascents between 25,000 and 27,000 feet within a week, the carriage by six porters of loads to a height of 27,000 feet; men have slept well in camp at 26,800 feet. The upper half of Everest consists of slabby altered limestones, a 1000-feet thickness of sandstone and fossils has been found, and in 1924 persistent cold winds blew from the west with night temperatures which fell once to −22° F. At Camp IV., 23,000 feet, twice in June, the noon sun temperature was 105° F., while the air temperature was only 29° F.

THE broadcasting last week of the speeches of the leading politicians of Great Britain proves that the influence of radio communication on the lives and affairs of men is already very great. Mr. Reith, the manager of the British Broadcasting Company, in an article in the October *Quarterly Review*, gives an account of the present position of the art and indicates some possible future developments. In less than two years the staff has increased from 4 to 350, and operations are now carried out nightly in twenty cities. A system of simultaneous broadcasting has been carried out for more than a year, and practically a million licenses have been issued. There are very few "blind spots," that is, regions which suffer appreciably from shielding, due possibly to hills,

where reception is in consequence difficult. In the nightly audience every grade of society, every standard of intellectual attainment, and every variety of taste are represented. The managers aim at giving satisfaction to three-quarters of the audience, three-quarters of the time. Their aim is both entertainment and instruction, and the educational possibilities are being rapidly developed. By the aid of the master microphone a single man can influence a nation, and through its agency the ideals of universal brotherhood can be broadcast over the whole world. At the present moment, by means of the cheapest crystal set, about 75 per cent. of the total population of Great Britain can listen in. A large fraction of the remaining 25 per cent. will be covered when the high power station thirty miles north of London is opened next year. This station has a guaranteed range of 100 miles for cheap crystal sets, 300 for single-valve sets, and about 1000 for two-valve sets. The Bethnal Green Borough Council recently suggested that they should erect a central aerial to supply the district, and so dispense with the necessity for independent aerials in every house. We think that the suggestion is impracticable, while the legality of such a proceeding is open to question; but many of the unsightly and unnecessary aerials hung out by tenants should be prohibited by law. The situation might be improved if radio manufacturers would advertise more largely the fact that in most cases, when electric or gas lighting is used, an aerial is unnecessary even with crystal sets.

SIR ARTHUR EVANS, in the *Times* of October 16 and 17, gives a further account of his work in Crete during the present year. Investigations of the neolithic remains immediately below the Central Court have brought to light three fragments of stone vessels to be related to the early Nilotic lapidary work. They are the first to be found in pure late neolithic floor deposits. Vessels of predynastic form and material had already been found at Knossos, but in unstratified earth. This discovery throws back the actual contact between Crete and Egypt and the closing phase of neolithic culture in the island to the middle of the fourth millennium B.C. The road from Knossos to the south coast has now been traced to a Minoan haven at Como round a headland north of the harbour of Matala. Excavation of the indurated clay at the point where this road abuts on the hillside below Knossos has revealed further details of the construction of the viaduct across the ravine and the entrance system of the palace, as well as the pavilion or caravanserai at the south-eastern extremity of the viaduct. This building of unique character faces north with a frontage of more than 160 feet. The walls of the pavilion, only the lower parts of which are standing, had been covered with frescoes, of which fragments preserved in the petrified ground have been pieced together and reveal a frieze of a novel character of naturalistic red-legged partridges and hoopoes on a highly conventionalised landscape background. The bath chamber adjacent had an elaborate system of conduit pipes. In an underground "fountain" chamber packed with votive vessels was found a primitive image of a goddess within a vessel shaped like a round hut—the Lady of the Source herself.

THE work of Prof. A. Maihle, of the University of Toulouse, on the catalytic effect of various contact materials on a great variety of materials, is well known to the organic chemist, but recent developments, from the point of view of the supply of fuel for internal combustion engines, have attracted considerable attention amongst fuel technologists. At a recent congress held in Paris, Maihle described his work on the pyrogenesis of fatty oils and showed how a copper-aluminium catalyst brought about the rearrangement of linseed oil into a synthetic petroleum. The fatty acid from arachin oil brought into contact with tested magnesium chloride yielded 68 per cent. of a "mineral" oil which contained motor spirit, burning oil, and more viscous components. A similar product was obtainable from chlorophyll, and it appears possible that even cellulose would be capable of yielding hydrocarbons. At the same time, it should be mentioned that the commercial possibilities of this work are probably highly overestimated. Up to the present date, less than one cubic mile of petroleum has been extracted from the earth's crust, and the world is faced to-day with over-production rather than with a deficit of mineral oil. Even when the known resources of petroleum are exhausted, there are untold volumes of potential liquid fuel derivable from shale, whilst the work of Bergius indicates that even when shales are exhausted, every coalfield is a nascent oil reservoir. In these circumstances it is difficult to see that the production of oil from vegetable sources is other than of scientific interest.

A SERIES of short instructions on the method of taking and reporting readings of temperature and rainfall has been issued by the Meteorological Office, Air Ministry. The pamphlet bears the title of "The Observer's Primer" and was primarily prepared for meteorological observers in British Crown Colonies. The instructions, if carefully considered by observers of the weather, will render the observations made of much greater value. Uniformity of system in observing is of primary importance, and careful readings of temperature and rainfall are of infinitely more value than minuteness in the fineness of reading. Instructions are given as to the exposure of thermometers and the position of the rain-gauge. The hints are essentially of value to new observers, and if followed will place the observer on the same footing as one who has already had experience.

MONTHLY normals of rainfall for the British Isles for periods ending 1915 have recently been published as Section V. of "The Book of Normals" by the Meteorological Office of the Air Ministry. The material has been prepared by the British Rainfall Organisation, which, since 1919, has been incorporated in the Meteorological Office. Monthly and annual values are given for 578 widely distributed places, compiled from the records for the 35 years

1881 to 1915. This period is chosen chiefly because it probably gives the largest number of synchronous and homogeneous records. Section V. covers the same ground as Section I., but it comprises many more stations; the additional information now available has been utilised for the present issue and where necessary corrections have been made. The arrangement of the stations is the same as that adopted in "British Rainfall" and differs from that of previous sections of "The Book of Normals." It is now easy for any inquirer to compare the very different amounts of rain which occur in different places. The modifications made in Section V. are fairly numerous, as is clearly seen from a careful examination. It is of general interest to see how on the same coast the average rainfall differs; at Eastbourne the total for the year is more than 3 inches heavier than at Worthing, and an excess is maintained in every month of the year. The mean for the 35 years at Greenwich Observatory is about 1 inch less than the mean for 100 years terminating at the same date; for the 35 years the mean for September is 0·47 inch less than December, while for the 100 years, September is wetter than December.

Two hundred years ago this month, the firm now known as Longmans, Green and Co., publishers, was founded by Thomas Longman, an ancestor of some of the present directors, and we are sure that our readers everywhere will join us in offering our congratulations on the completion of so long a period of public service. Thomas Longman was apprenticed to a bookseller in Lombard Street in 1716, and when his indentures ran out in 1724, he acquired the business of a publisher and bookseller in Paternoster Row at the sign of the Ship in Full Sail. That site marks the birthplace of the house of Longman, and it is interesting to note that, with the exception of a short period, 1861–63, when a fire made rebuilding necessary, a publishing business in the name of Longman has occupied the site continuously for two centuries, while the old sign has been adopted as the firm's trademark. From the date of its foundation onward, at least one Longman has been in the firm, and now the sixth generation is in possession. It is a fine example of the inheritance and development of traditions which have led to an important and ever-increasing business. Among the works issued by Longmans with which scientific workers will be familiar are Salmon's "Conic Sections," Herbert Spencer's "Principles of Psychology," Herschel's "Outlines of Astronomy," Webb's "Celestial Objects," and Gray's "Anatomy," which was published in 1858 and achieved its twenty-second edition last year. Then in the 'sixties came Tyndall's Lectures, while of more modern works we may quote Watt's "Dictionary of Chemistry," Sir Edward Thorpe's "Dictionary of Applied Chemistry," Mellor's "Inorganic and Organic Chemistry," which is now in course of publication, J. G. Millais' sumptuous volumes on British ducks and on rhododendrons, and Thorburn's equally beautiful works on British birds and mammals. The firm and its directors have a record of which they may well be proud, and we wish them long and continued prosperity.

THE seventh annual Streatfeild Memorial Lecture will be delivered at 4 o'clock on Thursday, November 6, at the Finsbury Technical College, Leonard Street, E.C.2, by Mr. Julian L. Baker, who will speak on "The Chemist and the Fermentation Industries."

THE Thomas Hawksley lecture of the Institution of Mechanical Engineers will be delivered at the institution at 6 o'clock on Friday, November 7, by Vice-Admiral Sir George G. Goodwin. The subject will be "The Trend of Development of Marine Propelling Machinery."

THE British Association for the Woollen and Worsted Industries is inviting applications from persons who have engaged in original research for the post of physicist. Applications stating academic qualifications, research work, and technical or engineering experience, if any, should be sent to the Secretary of the Association, Torridon, Headingley, Leeds.

APPLICATIONS are invited from holders of a university honours degree in science or engineering, or equivalent, with experience in engineering works, for a research assistantship at the Royal Aircraft establishment, South Farnborough, Hants, for work in connexion with aero engines. The applications, quoting reference No. 37, should be sent to the superintendent of the establishment.

THE Dorset Field Club announces that the Cecil Medal and Prize of 10*l.* will be awarded in May next for the best essay on "Broadcasting: its Possibilities and Limitations." The competition is open to persons between the ages of seventeen and thirty-five, born in Dorset or resident in that county for not less than a year between May 1, 1923 and 1925. Particulars of the competition are obtainable from Mr. H. Pouncy, Midland Bank Chambers, Dorchester.

A REPRESENTATIVE assembly was present at the memorial service for the late Sir William Herdman at the ancient chapel of Toxteth in Liverpool, on Thursday, October 16. The Mayors of Liverpool and Birkenhead, representatives of the University, the various civic bodies, the Royal Society, the British Association, the Marine Biological Association, the Liverpool School of Tropical Medicine, the Society of Chemical Industry, and other institutions attended. The Unitarian service was conducted by the Rev. C. M. Wright, the minister of the chapel.

IN addition to the development of commercial transport by rigid airship, the directors of civil aviation in the United States of America have a programme of semi-rigid airship construction and operation. The latter have the advantage of smaller size, first cost and running expenses, but have less speed, range and carrying capacity, and less ability to ride out a spell of bad weather. Available data are so untrustworthy that it is better to await the completion of the programme rather than to offer anticipations which can be little better than guesses.

THE following committee has been appointed by the Board of Trade to consider and report on the steps which can be taken to bring about the growing

of flax seed and flax in the British Isles on a commercial scale :—Sir Frank Warner (chairman), Mr. W. Norman Boase, Mr. J. G. Crawford, Sir A. Daniel Hall, Mr. A. L. Hetherington, Sir Thomas H. Middleton, and Mr. H. Mead Taylor, together with a representative, to be appointed later, of the Ministry of Commerce of Northern Ireland. The Secretary to the Committee, to whom all communications should be addressed, is Capt. S. E. J. Brady, Board of Trade, Great George Street, London, S.W.1.

THE Council of the Institution of Automobile Engineers has made the following awards for papers read during the past session :—Crompton Medal to Dr. Aitchison for his paper entitled "Light Alloys for Pistons and Connecting-Rods," and Utility Prize, given by Col. D. J. Smith for the paper of greatest utility to the automobile industry, also to Dr. Aitchison for the same paper; Graduates Prize to Mr. R. N. Aveline (Coventry Branch) for his paper entitled "Carburation."

IN the Report on the Raffles Museum, Singapore, for 1923, Mr. C. Boden Kloss, who has succeeded Major J. C. Moulton as director, announces that sanction has been given for a new wing on the site kept vacant for this purpose between the museum and the sea. The museum is becoming yet more frequently used by local residents who seek information from a scientific or commercial point of view. From near the summit of Gunong Angsi (2700 ft.), in Negri Sembilan, Mr. F. N. Chasen has obtained a specimen of a martin, *Chelidon dasypus*, the first one recorded from the mainland of the Malay Peninsula.

THE September issue of the Journal of the Franklin Institute gives an account of the presentation on May 21 of the Franklin medals to Sir E. Rutherford and Dr. E. Weston respectively. Unfortunately neither recipient could be present in person, but the former sent an interesting account of the events and ideas that guided him in his early researches in radioactivity, which was read by Dr. J. S. Ames, professor of physics in the Johns Hopkins University. Dr. Weston is well known as the inventor of the standard cell, but it is not generally known that he discovered and patented the resistance alloy now known as manganin, the manufacture of which was taken up in Germany. Dr. Weston was born in England in 1850 and went to America in 1870.

THE Technological Museum of Sydney has so high a reputation in Great Britain that it is disappointing to read in its latest annual report that "it has not received that appreciation of the public such an institution deserves." Since the attendance for the year was 43,138, since visits to the museum form part of the work of the elder scholars in the Secondary and High Schools, and since many manufacturers have generously augmented the industrial exhibits, we infer that the director is alluding only to the inadequacy of the State grant. The annual vote, which had been temporarily suspended, has indeed been restored, but the available money is not enough to meet the needs of the central museum and of the six country branches. Let us hope that, as the situation improves, the claims of this admirable institution may meet with due recognition.

IN the October number of *Scribner's Magazine* is an article on predicting earthquakes by Prof. T. A. Jaggar of the Hawaiian Volcano Observatory. Though he refers to one or two successful forecasts of volcanic eruptions, the article is rather a plea for the foundation of a geophysical observatory in New York, a plea supported by an account of an imaginary earthquake in that city in 1932. There is no reason, he considers, for regarding New York or Washington as immune from a shock like that of Charleston in 1886. Prof. Jaggar's view is partly due to a table of seismicity which he has compiled for various regions, depending on the number of earthquakes per year for an average square mile without regard to their intensity. In the eighth degree, he places New York and New England with central California and parts of New Zealand and Mexico. But, in the ninth degree, are included the north of England along with Asia Minor, Messina, and the Lesser Antilles; and, in the tenth and highest degree, Perthshire beside Manila, Guatemala, and Tokyo.

AT the opening meeting for the 1924–25 session of the Institution of Petroleum Technologists, held on October 7, awards of the Institution's medals and scholarships were announced. The Boverton Redwood Medal for the sessions 1919–20 and 1920–21 was awarded to M. Paul de Chambrier of Pechelbronn, for his paper on the "Working of Petroleum by means of 'Shafts' and 'Galleries,'" read before the Institution on February 15, 1921. This medal, presented to the Institution by Mr. Alexander Duckham to commemorate the late Sir Boverton Redwood, founder and first president of the Institution, is awarded to the author of the paper of the greatest merit on any subject connected with petroleum technology, presented to the Institution during two consecutive sessions, and is not confined to members of the Institution. The award has been made retrospective to 1919, the date of Sir Boverton Redwood's death. As there was no paper of outstanding merit for the sessions 1921–22 and 1922–23, no award has been made for those sessions. The Student's Medal and Prize has been awarded to Lieut. J. H. Blakiston, R.N.R., formerly student of the oil technology course at the University of Birmingham, for his paper entitled "The Oilfields of Roumania." This award is made to the student member of the Institution who presents the best paper on any subject connected with petroleum technology, in any one session. This is the first award of this medal and prize. A Scholarship has been awarded to Mr. Ernest Clark, of the Royal School of Mines. These scholarships are awarded annually, one each to the Royal School of Mines, Imperial College of Science and Technology, London, and to the University of Birmingham, to a third year student, taking the petroleum technology course, who is also a student member of the Institution.

A LARGE part of the Report of the South African Museum for 1923 is taken up by the late Dr.

Peringuey's complaint of the delay in providing additional buildings. The large whale skeletons that stood so long in the open—to their considerable detriment—have been covered by a T-shaped building of brick with asbestos roof; but for some reason this was not made large enough to include a fin-whale and a male sperm-whale. Counting these, all the cetaceans known to occur along the coast of the Union are represented, except two porpoises. Special mention is made of *Balænoptera rostrata* and *Neobalæna marginata*, which have not long been known to occur in these waters. Owing to the damaged condition of many skeletons, some new ones are required, but so far only one whaling company, and that a foreign one, has befriended the museum. An old iron and wood building was obtained to store some of the other vertebrate skeletons, and, pending the erection of a wing for which 20,000*l.* was voted in 1914, this has also been used for exhibition purposes. One of the wings of the main building has been lent to the Art Gallery, which also waits in vain for the completion of a promised building. Whatever be the cause, it is certainly regrettable that valuable collections should be suffered to decay for lack of halls and cases.

LAST year at about this time we were able to extend a welcome to the *British Journal of Experimental Biology*, which was the first periodical in Great Britain designed to cover this important and growing field. Other countries were already served by comparable publications. We now learn that an international journal of general biology, under the title of *Biologia Generalis*, is to be issued shortly under the editorship of Prof. Leopold Löhner, of the University of Graz, Prof. Raymond Pearl, of the Johns Hopkins University, Baltimore, and Prof. Vladislav Ruzička, of the Charles' University, Prague. The list of co-editors, who will presumably form an editing committee, contains the names of biologists from most European countries and also from the United States of America. It is proposed to publish original articles on general morphology, physiology, and ecology, and contributions will be printed in English, French, German, Italian, or Russian. The publishers of the new journal are Messrs. Emil Haim and Co., Vienna 1, Maria Theresienstrasse 10, and Bratislave, C.S.R., or, in the United States, through the Johns Hopkins Press.

MR. H. KIRKE SWANN is publishing, through Messrs. Wheldon and Wesley, Ltd., in 12 parts, a limited edition of "A Monograph of the Birds of Prey (Order Accipitres)." The work will be illustrated in colour by H. Gronvold, and the first part is promised for November 15.

Our Astronomical Column.

THE ASTRONOMICAL DAY.—In a recent notice in this column of the Brussels Annuaire, it was stated, on the authority of the Annuaire, that the "Berliner Jahrbuch" for 1925 was not participating in the change of the commencement of the astronomical day from noon to midnight. Examination of next year's issue of the Jahrbuch shows that this statement is incorrect; that publication comes into line with all the other national ephemerides, which is a matter of congratulation, as a variety of usage in different countries would be a source of frequent errors. It is not too early to remind astronomers to make the change in any publications relating to next year's work. In a few cases it has been overlooked.

THE STARS OF TYPE O.—An important monograph on these stars by Dr. J. S. Plaskett forms vol. ii., No. 16, of the Publications of the Dominion Astrophysical Observatory. They are the most massive of any type; their mean mass is shown to be some 45 times that of the sun, the probable range being from 10 to 80 times that mass. The mean mass for early B stars (Bo to B5) is 10 times that of the sun.

In spite of the high mass, the O stars have the high average radial velocity (cleared of sun's velocity) of 25·5 km./sec., which is higher than that of any type except the M variables (35 km./sec.). The total space velocity is twice as great.

The close relationship between O stars and planetary nebulæ has been indicated before, but is further demonstrated.

The mean parallax of the O stars is difficult to determine, owing to their small proper motions. It is found to be about 0·0011″ for 6th magnitude stars, indicating a distance of 3000 light-years and an absolute magnitude of $-4^{mag.}$, which agrees with Eddington's mass luminosity relation.

The monograph proceeds to discuss the fixed H, K calcium lines, supposed to indicate cosmic clouds between the earth and the stars, excited by their radiation. The Wolf-Rayet or "Emission O" stars are also discussed. Dr. Plaskett adopts the notation of O5 to O9 for the Harvard Oa to Oe. He proposes that the suffix *e* should be used to denote the presence of emission lines.

Many of the spectra discussed are reproduced in three plates at the end of the work.

STELLAR DISTRIBUTION.—The researches of Mr. K. G. Malmquist on this subject were recently noted in this column. The question of the relative frequency of the different spectral types, and of the giants and dwarfs of the same type, is of such fundamental importance in stellar cosmogony that it is of interest to give for comparison the figures given by Prof. Harlow Shapley (*Scientific Monthly*, May 1924) for the numbers of stars of different types contained in a cube the side of which is 100 parsecs; they are Giant M 22, Giant K 160, Giant B 4·4, Giant A 250, Dwarf F 680, Dwarf G (solar type) 7600. He notes that Dwarf K and M would far outnumber the last, but exact data are not available. He concludes from the small figure for Giant B that extremely few stars have sufficient mass to attain so high a temperature. It may also indicate that stars do not remain in this stage for long. Stages K and A appear to be much longer.

Prof. Shapley concludes that 95 per cent. of the stars in the Henry Draper Spectral Catalogue are within 1000 parsecs of the sun; this region is only one-millionth of that which he believes from his researches on the clusters to be closely populated with stars. The paper also deals with the galactic concentration of different types. This is great for B, A, slight for F, G, moderate for K, M.

Research Items.

BABYLONIA AND EARLY INDIA.—In further reference to the discovery of an early Indian civilisation at Mohenjo-Daro and Harappa (see NATURE, October 18, p. 584), it may be of interest to note that the chief points of resemblance between the objects from these sites and Babylonian antiquities to which Messrs. Gadd and Smith direct attention in the *Illustrated London News* of October 4, are as follows:—The seals are similar in shape to square stamp seals from Susa and Babylonia (3500–2500 B.C.), while the engraved bulls on them are distinctly Sumerian both in general appearance and in detail. They stand before a cult object in a position familiar in Babylonian art of all periods, and if the object were a sheaf, this would closely resemble the Sumerian picture sign *Zag*. Of the signs on the seals, obviously some form of writing, nine very closely, and seven partially, resemble Sumerian writing. The numeration system appears to be the same. A cylindrical piece of hæmatite with flattened ends from Mohenjo-Daro recalls a common type of weight from Babylonia. The curious stone rings may be compared to Babylonian mace heads, and, like them, may be votive offerings. Shell inlay, of which pieces have been found, is one of the most characteristic features of early Sumerian culture. The figurine of a cock from Mohenjo-Daro finds a parallel in a clay figurine of a hen from Ur. The style of brick building, with its drainage system and ornamentation of glazed bricks, closely resembles the style of buildings brought to light by the recent excavations at Ur. The miniature funerary pottery from Mohenjo-Daro is similar to miniature pottery from Ur which belongs to the second millennium. Painted pottery from both Susa and Babylonia antedates 3000 B.C. It belongs, however, to a period when metal was only just coming into use, as appears to be the case on the Indian sites.

ANCIENT CLEPSYDRÆ.—In most early civilisations means were devised for measuring time, and in ancient Egypt, while sun-dials or shadow-clocks of various types were used to indicate the passage of time during the day, water-clocks were employed at night. In an article in *Ancient Egypt* for June, Mr. R. W. Sloley describes two of these water-clocks. The older of them dates from about 1400 B.C. and was found at Karnak in 1904; it is now in the Museum at Cairo. In this type the surface of the water in a vase of the shape of the frustum of a cone fell through approximately equal intervals in equal periods of time as the water flowed out through a small orifice at the base. Among the Græco-Roman papyri found by Grenfell and Hunt at Oxyrhynchus is a fragment dating from the third century B.C. in which are given instructions for constructing the scales for one of these "outflow" water-clocks. The second one is probably an "inflow" clock, of which an example dating from Ptolemaic times was found at Edfu. In this type the water chamber is cylindrical, and it would appear that water flowed into it at a constant rate, causing a float to rise, though the lines which are scribed on the inside of the vessel scarcely support this view; on the other hand, they are difficult to see and could not have furnished a convenient means of reading the time directly. Casts of both of these water-clocks and one of a shadow-clock—which was used during the day in ancient Egypt—may be seen in the Science Museum at South Kensington. Thus in ancient Egypt the priests, by observing the culmination of different stars with the aid of a plumb-line and sight-vane, could determine sufficiently for their purposes different hours of the night; and with the water-clocks they could measure the passing of the hours. The shadow-clocks, which showed approximately the number of hours which had elapsed since sunrise, or which remained before sunset, were probably in more general use among the people; the distribution of water by a water-wheel or the working-periods of different pairs of oxen are still checked by little shadow-clocks made of a few pieces of millet (durra) stalk by the cultivator for his guidance.

CHILDBIRTH CUSTOMS AMONG THE INDIANS OF NEW MEXICO.—In *Man* for October, Dr. Elsie Clews Parsons describes a number of interesting customs relating to mothers and children among the Tewa Indians. An eclipse of the moon occurring during pregnancy is believed to cause deformities of mouth, foot, or hand. Therefore an expectant mother carries a key, stone, or something hard in her belt so that "the moon won't eat the baby." At an eclipse "when the moon dies," a woman is told not to go out of doors. The mother lies in for three days; on the fourth day the child is named, the attendant aunts, paternal and maternal, giving the names. In the course of the ceremony one of the aunts, called the navel mother, takes a mouthful of water from an abalone shell which has been used for bathing the child, and in which has been placed a fetish stone. With this water in her mouth she breathes along an ear of corn. The ear is waved in six directions, and the water ejected into the mouth of the infant. This rite is repeated for a second ear. The two ears are left on either side of the child for ten or twelve days. They are planted in the following year. The object of using these sacrosanct ears is that the baby may grow up perfect like the corn ear.

IMPLANTATIONS OF TESTIS AND OVARY.—Knud Sand in *Endocrinology* (vol. 7, pp. 273-301, 1923) gives a summary of his experimental results published in 1918 in a Danish monograph. He confirms Lipschutz's observations of hypertrophy of the clitoris following iso-transplantation and gives a preliminary account of two cases of testis-implantation in castrated homosexual human males and of the successful regeneration of a 12½-year old dog by means of resection of the left epididymis and right-sided vasectomy. He is of the opinion that Leydig's cells are substantially the most important tissue in the production of the male sex-hormones. In the matter of ovarian grafts, he finds that the place of implantation and the relatedness of donor and host are factors of slight importance. One point of considerable interest emerges from his observations on the artificial hermaphrodite. Apparently mammary activity with milk secretion can be produced in a male organism in the entire absence of corpora lutea, uterus, and pregnancy.

VASECTOMY AND SIMILAR OPERATIONS.—In *Acta Chirurgica Skand.* (vol. 64, pp. 387-426, 1922) Sand gives an English edition of his paper in Danish (Ugeskrift for Laeger., 1922) dealing with the operation of vasectomy for regeneration. He prefers to free the epididymis and resect a portion under local anæsthesia. An account is given of thirteen patients treated for senium præcox and of five younger men treated for impotency, who have been under observation for 3-21 months. In the first group nine, in the second four, benefited by the operation. The rest were unsuitable cases. Sand adopts a very cautious attitude. In *Skand. Archiv f. Physiologie* (vol. 44, pp. 59-75, 1923) the same author describes the case of

a 10-year old individual, brought up as a boy, with imperfect external genitalia. An explorative operation was performed and a uterus and two Fallopian tubes were found. On the right side there was an infantile testis, on the left what appeared to be an embryonic ovary. The author discusses the question as to what gonadial tissue should be implanted and suggests that when puberty is reached indications will be forthcoming. In *Abhandlungen aus Handwörterbuch der Sexualwissenschaft* (Marcuss and Weber, Bonn, 1923) Sand deals with certain aspects of sexual physiology (such as sex-reversal, hermaphroditism, gonad transplantation, regeneration, cryptorchism, vaso-ligation) in which he is an authority, in a concise yet encyclopædic manner.

MOLLUSCA OF COLORADO.—Mr. J. Henderson's previous catalogue of the Mollusca of Colorado, published in 1907, being out-of-date and out of print, the author has compiled a fresh one (Univ. Colorado Studies, vol. xiii. No 2), extending the area treated so as to include the States of Utah, Montana, Idaho, and Wyoming, which appear to constitute a rather distinct molluscan province, characterised (except at its northern border) by the absence of Polygyra and by the presence of Oreohelix. The amount of work which a valuable compilation of this sort entails is well gauged by the bibliography and synonymies, whilst its utility is enhanced by the numerous illustrations in the text and on photographic plates. By the time a further edition is required, and we trust it may be soon, it is to be hoped Mr. Henderson will have seen his way to a more modern system of classification, for it has long ago been shown that Vallonia and Cochlicopa belong to the Pupillidæ, being Orthurethra and not Sigmurethra, whilst Succinea represents the Heterurethra; further, Dr. Sterki, whom he has followed for Pisidium, will have realised that two years before he announced the discovery in America of the *Pisidium parvulum* of Clessin, it had been shown to have no existence, being a composite of other and well-known species, whilst the form to which Dr. Sterki attaches that name is probably the *P. moitessierianum* of Pallary.

THE MECHANISM OF ADAPTATION.—Professor L. Diels of Berlin, writing in *Naturen* for July on how the shapes of plants are affected by climate, puts the difficulty of explaining the mechanism of adaptation very clearly. While adopting a cautious attitude, he concludes that "in one way or another there may be some truth in the ideas of Lamarck, though experiment has not yet enabled us to decide wherein that truth consists. Without the Lamarckian theory geographic adaptations in the organic world would be nothing but a puzzle." Prof. Diels recognises, no doubt, that a whole-hearted acceptance of the Lamarckian theory still leaves us to find the mechanism by which new somatic characters are transmitted to the germ.

PARAMO PLANTS OF THE COLOMBIAN ANDES.—The Philadelphia Academy of Natural Sciences has turned its Annual Report into a Year Book, but the change seems to be confined to the title. Both in the first of the new series and the last of the old a large part is taken up by attractively written and well-illustrated accounts of explorations and collecting trips conducted on behalf of the Academy. As an example may be chosen Dr. F. W. Pennell's narrative of a botanical expedition through the Andes of Western Colombia in 1922. The features of chief interest were the lofty wind-swept moors known as Paramos, where the plants protect themselves from the bitter blasts either by donning a woolly coat, by spreading prostrate along the ground, or by forming dense cushions of almost rock-like hardness. The most characteristic of the woolly plants are the "frailejones," usually species of Epeletia, one of which reaches a height of 10 ft. Each isolated region of paramo appears to have developed its peculiar "frailejones," and Dr. Pennell suggests that a knowledge of the relations of these species would greatly assist a reconstruction of recent geological history in the northern Andes.

SKULL OF DINOTHERIUM.—In the Memoirs of the Geological Survey of India (vol. vii. No. 4, 1924) has appeared an account, by the late Captain R. W. Palmer, of an incomplete skull of Dinotherium. Remains of this genus are usually so fragmentary that every account of new material is of value even if it does no more, as in the present instance, than confirm previous accounts. There is no editorial note to show when the manuscript was completed, but it is likely that the author's health, before his much to be lamented death in October 1922, prevented his seeing a paper by Andrews published in 1921 and one by Forster Cooper in 1922 on the subject of Dinotherium, both in the Proceedings of the Zoological Society. The specimen described is an incomplete fragment of a skull showing the basal surface from the condyles to the pterygoid region. The anatomical features shown do not differ markedly from those described by the late Dr. Andrews for the celebrated skull of *Dinotherium giganteum* in the British Museum, but the new specimen being in better condition, certain points are more clearly established. With regard to the question of the validity of the Indian species *D. indicum* and *D. pentapotamiæ*, the author concludes that they cannot be upheld and that they are both to be referred to the European form *D. giganteum*. This agrees with the views already published by Forster Cooper which were the outcome of a study of material from Baluchistan.

THE STRUCTURE OF LIGHT.—In the October issue of the *Philosophical Magazine*, Sir J. J. Thomson gives an account of a mental picture based on the idea of tubes of force which he has used for some time to reconcile the optical properties of light, which point to a wave theory, with the electrical properties, which demand some form of corpuscular theory. When an atomic electron falls towards its positive nucleus, the tube of force connecting them is not shortened, but forms a loop which may detach itself from the rest of the tube and move off as a free ring. Its emission is radiation, and the energy radiated is concentrated in the ring. Such a free ring may strike another tube and, in coalescing with the tube, lengthen it either temporarily or permanently. If the association is temporary only and the ring is thrown off, there is no absorption; if permanent, the electron has moved out from the nucleus and absorption has taken place. This picture is shown to be in keeping with the quantum theory and the principal facts of absorption and resonance.

THE HARDNESS OF SCATTERED X-RAYS.—An apparatus for measuring the hardness of X-rays, scattered through different angles, is described by Messrs. F. Dessauer and R. Herz in the *Zeitschrift für Physik* of August 28. Preliminary measurements have been made, in which the X-rays were filtered through 4 mm. of aluminium, so that they belonged to a narrow spectral region; they were sent in a narrow beam through holes, 5 mm. in diameter, in a series of concentric cylindrical lead screens, on to a sphere of paraffin placed at the axis of the cylinders. A series of holes in the lead cylinders allowed scattered beams, about 8 mm. in diameter, to pass outward at

angles 30°, 60° . . . 150°, and fall upon a photographic film, which was bent into a cylinder coaxial with the lead screens; the lower half of each beam passed through an aluminium filter. A movable lead screen, with rectangular openings, made it possible to expose narrow vertical strips of the small circular patches formed on the photographic plate, for regularly increasing periods, 100, 200, 300 . . . minutes, up to a total exposure of ten hours; thus the calibration of the photographic blackening, as a measure of the intensity of the radiation, can be made separately for each angle of scattering, *i.e.* for each wave-length. Since the whole series of observations is made simultaneously on the same photographic plate, some of the possible errors are eliminated and others greatly reduced. It is possible to deduce, from the photometric measurements of the blackening, the wave-lengths of the rays scattered at different angles. The results obtained agree fairly well with those calculated by means of Debye's theory, thus confirming Compton's results. Measurements in which monochromatic radiations are employed are in progress.

THE GEIGER α- AND β-PARTICLE COUNTER.—Dr. H. Geiger discusses the working of the pointed electrode counter in the *Zeitschrift für Physik* of August 28. If the counter is 2 cm. in diameter, a β-particle produces primarily some 50 ions, or 2×10^{-8} electrostatic units; while, according to the voltage employed, the rush of electricity will be from 0·1 to 1 unit. It seems clear then that an α- or β-particle causes a momentary discharge; but it is difficult to explain why this discharge breaks off so suddenly. Dr. Geiger has connected the point electrode to a string electrometer, earthing them through a high resistance such that the time the charging rush lasts is small compared with that which it takes to leak away; if a capacity several times as large as that of the electrometer is then connected in parallel, the deflexions are reduced, and are roughly inversely proportional to the capacity, so that in each discharge the same quantity of electricity flows. It is not the rise of voltage caused by the current rush which stops the discharge, for if this were the case the deflexion would be independent of the capacity. The point electrode in general requires a certain preparation before it will work properly; the form of the point and the degree of polish have little influence, but heating to incandescence will generally make the point active. Apparently the point becomes covered with a surface layer having a high electrical resistance; since platinum is a suitable material, this layer can scarcely consist of an oxide; the alteration seems rather to depend on the gas which covers the metal. Janitzky has shown that in an X-ray tube no discharge takes place from an electrode which has been perfectly freed from gas. On Geiger's theory, when a rush takes place, the outside layer of this surface film becomes charged, and the potential difference between this surface and the surrounding walls falls rapidly, so that the current stops soon after it commences.

A NEW BLEACHING REAGENT.—A new bleaching reagent for use in laundries is described by Dr. R. Feibelmann in the *Chemiker Zeitung* (1924, vol. 48, p. 685) under the name of *activin*. This compound is the sodium derivative of *p*-toluene sulphochloramide, $CH_3 . C_6H_4 . SO_2 . NClNa + 3H_2O$, and belongs to the class of chloramines. Although the oxidising power of activin is due to "available" chlorine, it is much milder in its action than the hypochlorites though more effective than sodium perborate. Moreover, it possesses several advantages over the latter. Thus it is not easily decomposed by heat and it is not sensitive to the catalytic action of traces of copper and other metals, a property which is apt to render sodium perborate destructive to fabrics. It acts as a powerful germicide, being indeed comparable with corrosive sublimate in this respect.

EFFECT OF MOTION ON CHEMICAL CHANGE.—The April-July volume of the *Compte rendu des Séances de la Société de Physique*, of Geneva, contains a paper by Duparc and Molly on the above subject. The authors examined the reaction between marble and a solution of ammonium chloride, both when the mixture was agitated, so that the pieces of solid rubbed against one another, and again when the liquid was merely circulated around the pieces of solid. It is claimed that the results were different in the two cases. In the first experiment the quantity of calcium carbonate dissolved increased to a maximum and then decreased, whilst in the second experiment a state of equilibrium was reached. It was shown that in the first case the solution contained free ammonia, and the reaction was assumed to occur according to the equation: $2CaCO_3 + 2NH_4Cl = CaCl_2 + Ca(HCO_3)_2 + 2NH_3$, whilst in the second case the reaction $CaCO_3 + 2NH_4Cl = CaCl_2 + (NH_4)_2CO_3$ attained a state of equilibrium.

THE DELAWARE RIVER BRIDGE.—This suspension bridge is in course of erection over the Delaware River between Philadelphia and Camden. The estimated amount of load which the cables will ever have to carry is nearly 60,000 tons, and requires two 30-in. diameter steel cables, each weighing nearly a ton per foot of length and each subjected to a maximum pull of 20,000 tons; there will be 18,000 wires in each cable. The design and construction of the anchorage for resisting these enormous forces is of particular interest, and an extremely lucid account will be found in the Journal of the Franklin Institute for September, where the design is treated by Mr. Allston Dana, of the Delaware River Bridge Joint Commission, and the construction by Mr. Montgomery B. Case, who is the senior resident engineer on the bridge. The anchorages are separated by a distance of about 0·6 mile, and will be concrete structures faced with granite, 218 ft. long, 190 ft. wide, 175 ft. above ground, and with foundations extending down to rock 65 ft. below ground in Philadelphia and 105 ft. below ground in Camden. Each anchorage will weigh 5 or 6 times as much as the pull exerted on it by the cables. The cables will enter the anchorage at points 130 ft. above ground and at an inclination of 8° with the horizontal; they will then bend over the top of an inclined steel tower and will pass down into the anchorage at an inclination of about 45°. Forty feet down each cable will be incased in a cast steel band the lower part of which is bell shaped, and the cable will then flare out in all directions, and will be looped round a group of 61 cast steel shoes connected to eyebars, which in turn will be connected to anchor girders placed as far down in the corner of the anchorage as practicable. The design of the anchorage structures introduces some very interesting calculations which are explained clearly by Mr. Dana. The caissons were sunk by dredging and their behaviour varied widely with the class of material under penetration. In sand and gravel the caissons followed the dredging gradually, whilst in clay or disintegrated rock they frequently held up until the excavation was 10 ft. or more below the cutting edge, when a sudden drop would occur and the cutting edge forced the material to the centre of the dredging. The paper is profusely illustrated with drawings and photographs, and we can recommend its perusal to all students of civil engineering.

Transmission of Stimuli in Plants.[1]

MR. R. SNOW has conferred a real benefit on botanists by reviewing Ricca's important experimental investigation on the conduction of stimuli in Mimosa, and by discussing the evidence for the conclusions of that Italian investigator which originated such an unexpectedly simple theory for the conduction of stimuli in plants. In the paper before us Mr. Snow describes how the experiments which Ricca performed on the conduction in the stem of *Mimosa spegazzinii* were repeated on *M. pudica*, and states that Ricca's explanation of the conduction, as depending on the transference of a hormone in the transpiration-current in the wood of the stem, has been tested and may be accepted as correct.

It will come, however, as a surprise to most physiologists that Mr. Snow does not consider this mechanism adequate to explain all the forms of conduction in *Mimosa pudica*. He believes that there are three types of transmission, namely, (1) The "normal" conduction in the transpiration-stream, elucidated by Ricca; (2) "high speed" conduction in the cambium or inner layers of the phloem, and (3) leaf-conduction in the phloem. Such a point of view demanding a special hypothesis to meet each type of conduction is not likely to find favour unless there is evidence to show conclusively that the original theory alone is unable to explain the experimental results. It may be stated at once that such evidence does not appear to be forthcoming.

First, with regard to the "high speed" conduction: This type is observed when a small lesion is inflicted on the inner layers of the phloem of the stem, or, occasionally, when an internode of the stem is cut through. In these cases the nearest one or two leaves above the cut are seen to fall practically simultaneously with the administration of the stimulus, while in "normal" conduction several seconds are required to traverse an internode. The reaction in the cases of "high speed" conduction also differs from that of "normal" conduction in that it involves only the main pulvinus and not the pinnules of the leaf. From the evidence, however, which Mr. Snow presents it does not seem probable that these two types differ essentially from one another. Assuming the liquid in the xylem is in tension, the rapidity of the motion of a hormone introduced into the xylem will depend on the relation of the cross-section of the conduit, in which the hormone moves, to the volume of the liquid moved by transpiration and by the elastic recovery of the tissues. Thus, if the motion upwards is confined to a slender linear series of tracheæ, the velocity will be high, while if a woody conduit having a large cross-section can be utilised, then the velocity will be small.

The method of experimentation described by Mr. Snow on p. 352 of his paper is just such as would produce a rupture of the tensile sap in one or two tracheæ and so allow the tensile liquid, having dragged in the hormone from the wounded cells, to hurry it upward in an instantaneously shortening filament of sap. The volume of this rising fluid is necessarily very small. Hence it is found able to affect only the pulvini of the reacting leaves and does not extend to the pinnules. Similarly it is evident that, where an internode is cut across, the velocity of the transfer of the hormone will depend upon the relation just pointed out. Consequently, the accident as to how exactly the cut is made, together with its chance relation to the transverse septa in the vessels, etc., will decide whether the conduction will be "high speed" or "normal." In this connexion Bode's observation should be borne in mind. He found that the tensile sap in tracheæ is ruptured by the pressure of a metallic point on the cells adjacent to the tracheæ. Thus we must infer that a rupture will take place in the sap just as the pressure of the blade producing the stimulus injures the semi-permeable protoplasm of the cells.

In the second place, Mr. Snow's reasons for assuming that the mechanism for the transmission of stimuli in leaves is fundamentally different from that in stems do not appear convincing. His first argument for this conclusion is that the rapid conduction observed in submerged leaves, or in those in a nearly saturated space, would be impossible if conduction depended solely on the movement of the transpiration-stream. It must be remembered, however, that, even in leaves in these conditions, there is evidence that tension exists, and that the turgescence (suction force) of the uninjured cells will draw liquid from the permeable injured cells back along the xylem. The very small cross-section of the xylem in the leaves will render the velocity of this motion comparatively great. Mr. Snow also believes that the fact, that in the leaf basipetal is as fast as acropetal conduction, shows that the conduction-mechanism of the leaf differs from that of the stem. This is just what we would expect if the hormone travels in the tensile sap; for the tension is hydrostatic and the resistance is the same in both directions.

Mr. Snow further finds support for his contention in Herbert's observation, that the velocity of conduction in the leaf is dependent on the intensity of the stimulus, while in the stem it is not so. Mr. Snow's own observations on "normal" and "high speed" conduction show that this rule is not without its exceptions. The fact that the volume of the tracheæ of the leaf is small compared with that of the stimulated cells furnishes a rational explanation of those cases where this difference is observed. This also accounts for the greater rapidity and greater certainty of the conduction in the leaf.

Again, the observation that an eosin solution is not always drawn back into the tracheæ of a responsive leaf cut under the stain, does not show, as Mr. Snow suggests, that in these cases there is no basipetal current in the tracheæ available for transport. Rather the failure of the stain to enter and pass down the xylem is almost certainly due to the unwettable surface of the leaf, which secures that the air adhering to the surface enters the tracheæ and prevents the eosin following the retreating sap. Mr. Snow himself instances a case where the eosin was drawn in 1·25 cm. in 60 seconds. In my own experiments I have observed a downward motion of the dye of 2·75 cm. in 40 seconds in the same circumstances. Lastly, in Mr. Snow's experiments, where transmission was observed in leaves after the continuity of the xylem had been broken by a cut not involving the phloem, there is no evidence produced that the hormone did not pass in the liquid filling the cut. Such transference has been shown to take place in stems and it is hard to see why it should not do so in leaves.

With regard to the nature of the hormone responsible for evoking the reactions, Mr. Snow has made some interesting observations. The hormone may be rendered inactive by dilution, and probably by boiling. Ricca found that of *M. spegazzinii* was not thermolabile. It is not precipitated by a protein-precipitant. It diffuses through a collodion shell. It is not injured by desiccation, nor by treatment by strong alcohol.

HENRY H. DIXON.

[1] R. Snow, "Conduction of Excitation in Stem and Leaf of *Mimosa pudica*," Proc. R.S., Series B, vol. 96, No. B 678.

The Scattering of X-rays.

IN an exceptionally successful session of Section A of the British Association at Toronto this year, perhaps no discussion created such widespread interest as that which centred round the papers of Prof. A. H. Compton of Chicago, and Prof. Duane of Harvard, on the scattering of X-rays. The subject is one which has had considerable influence on the development of modern physical theory. It was as a result of the theory of scattering advanced by Sir J. J. Thomson that Barkla was able to deduce from his experiments that the number of electrons in the atom was approximately equal to one-half of its atomic weight, a result confirmed by other methods some years afterwards by Moseley. Later developments indicated that the phenomenon of scattering was more complex than Thomson's theory assumed. The work of various observers on γ-rays showed that the absorption of these rays was greater after scattering than before, a fact which suggested that during the scattering there was a shift in the wave-length towards the long wave-length end of the spectrum. Similar results had been obtained with X-rays. Recent developments of X-ray technique have made it possible to carry out experiments of a much higher order of accuracy and have placed at the disposal of the physicist powerful sources of monochromatic radiation. It was natural, therefore, to expect that the problem would be attacked anew, and this has been done by several observers, notably Compton and Duane.

Compton's work was undertaken primarily to test the truth of a theory advanced independently by himself and by Prof. Debye of Zurich. The theory is of great interest, and a brief sketch may be given. Whereas the original theory proposed by Thomson was based on classical electromagnetic conceptions, that of Compton and Debye is founded on the quantum theory. In the simplest case a quantum of radiation of frequency ν falls on the scattering substance, and may be considered as colliding with an electron which is either free or very loosely bound to an atom. This electron takes up some of the energy of the quantum, and the radiation passes on as a quantum of somewhat lower frequency. The remainder of the energy appears as kinetic energy of the electron. It is assumed that, during the encounter between the radiation and the electron, the laws of conservation of energy and momentum are obeyed. The energy of the quantum is $h\nu$ and its momentum is taken as $h\nu/c$, where c is the velocity of light. If the equations representing the conservation of energy and momentum are solved, it is found that the change in wave-length of the radiation scattered in a direction making an angle θ with the original beam is given by $h/mc(1-\cos\theta)$ or $0{\cdot}024(1-\cos\theta)$ Å.U.

If this theory is correct, and we allow a beam of monochromatic X-rays to fall on a scattering substance and analyse the radiation scattered at an angle θ, we should expect an increase in wave-length of $0{\cdot}024(1-\cos\theta)$. Such a change is well within the range of measurement of modern X-ray spectroscopy. Compton conducted a series of experiments on these lines, and found that in the scattered radiation two wave-lengths predominated, one being identical with, the other longer than, that of the unscattered beam. The difference in wave-length was found to agree within experimental error with that predicted by the theory. Again, the separation of the two depended on the angle of scattering in just such a manner as anticipated by the theory. Further, a series of absorption experiments yielded results consistent with his hypothesis, and, finally, a study of C. T. R. Wilson's track photographs revealed the existence of electrons with the energy and direction of motion to be expected.

Further confirmation of the Debye-Compton theory came from independent observers, notably Profs. Ross and Bergen Davis. Ross used a photographic method instead of the ionisation apparatus employed by Compton. He found two lines on his plates, one corresponding to the wave-length of the original beam, the other to a radiation of longer wave-length. The separation increased with the angle of scattering as in Compton's experiments.

Had it not been for the experimental work of Duane, there is little doubt that these results would have been generally accepted as affording strong evidence in favour of the theory, if not as entirely establishing it. For the past year or two, however, Duane and his research school have been engaged on a series of experiments on the radiation emitted from various substances when bombarded by X-rays. They find, in addition to radiations identical with the primary beam, other radiations of longer wave-length. Their measurements indicate that these can be explained as due to the photoelectrons ejected from the matter by the primary radiation. It requires a certain amount of energy to eject an electron from its parent atom, the amount depending on the energy level from which it has to be removed. The kinetic energy of the electron will be less by this amount than the energy corresponding to a quantum of the X-radiation. If, in their turn, these electrons strike other atoms of the scattering substance, they will give rise to X-rays the maximum frequency of which will correspond to their kinetic energy in accordance with the Einstein equation $\frac{1}{2}mv^2 = h\nu$.

Duane finds that his experiments are consistent with such an explanation. It is clear that, on this theory, different substances will give rise to different radiations according to the energy required to remove an electron from the matter. On the Compton-Debye theory the wave-length of the softer radiation is independent of the nature of the scattering substance. In the case of carbon bombarded by the K radiation of molybdenum—the rays used by Compton—the chief effect observed by Duane nearly coincides with the Compton effect, but for heavier atoms the two theories give rise to radiations of different wave-lengths. Duane found that, with his apparatus, he was unable to find evidence for the existence of the effects observed by Compton, Compton, on the other hand, could not repeat satisfactorily Duane's experiments. A matter of such importance could not be left in such a position. Each observer investigated the apparatus used by the other and convinced himself of its trustworthiness. Duane observed that the only obvious difference in the experimental arrangements was that Compton's X-ray tube was enclosed in a wooden box covered with lead, while his own tube was not so enclosed, the tube being in one room and the rest of the apparatus in the adjoining room. Improbable as it appeared that such a difference could account for the difference in the experimental results, Duane tried the effect of such a box and found to his surprise that, in addition to the effects he had previously observed, a new peak appeared in approximately the position observed by Compton. The exact position of this effect depended on the orientation of the box. At the time of the Toronto meeting this represented the state of affairs.

In the general discussion various other members took part. Prof. Webster gave a detailed description of the experimental arrangements used by Ross, and

contended that the box in which Ross's tube was enclosed could not possibly account for the results he obtained. Prof. Gray described experiments on γ-rays and showed that they were consistent with the Compton theory. Prof. Raman made an eloquent appeal against a too hasty abandonment of the classical theory of scattering. Compton sketched an extension of his theory in which he considered not only free electrons but also those which were more tightly bound. He showed that the extended theory gave rise in the limiting case to the formula used by Duane and therefore embraced Duane's results. The fundamental difference between the two theories remains; Duane uses only the well-established quantum energy equation, while Compton in addition introduces the idea of conservation of momentum in the interaction between the radiation and matter. There are difficulties in the way of both theories, but at the present stage of the experimental work it is needless to dwell upon them. Before the theoretical side of the question can be satisfactorily discussed, further experimental work must be done. At the time of the meeting each observer appeared to have almost overwhelming evidence in favour of his point of view, and had the audience only had to listen to one side—either side would have done equally well—it would probably have been convinced as to the accuracy and soundness of the views advanced. As it was, however, the average member left the meeting inclined to echo the sentiments of the lover in the "Beggar's Opera" who sings,

"How happy could I be with either,
Were t'other dear charmer away!"

The Spectrohelioscope.[1]

By Prof. GEORGE E. HALE, For. Mem. R.S.

MONOCHROMATIC images of the sun, photographically recorded with the spectroheliograph, reveal the phenomena of the solar atmosphere in projection against the disk. The light from a spectral line of calcium, hydrogen, or other substance is singled out by a narrow second slit, which moves across the plate while the first slit moves across the solar image. A monochromatic picture is thus built up of countless narrow slit images, recorded side by side in slow succession.

The vortices and other significant structures thus disclosed, with the exception of an occasional brilliant eruption or unusually dark hydrogen flocculus, are beyond the reach of visual observation with the spectroscope. The simple method of opening the slit, which affords an excellent view of prominences at the sun's limb, because the light of the sky is sufficiently weakened by dispersion, is seriously limited when applied to the intensely brilliant disk. Even with the highest dispersion the slit cannot be opened sufficiently to reveal the characteristic structure of the dark hydrogen flocculi. Moreover, with a widened slit the image is not strictly monochromatic.

This simple expedient of rapidly oscillating the narrow spectroscope slit, and synchronously with it a second slit transmitting the Hα line to the eye, was tried by the earliest observers of the prominences. With suitable precautions this device gives excellent images of prominences through persistence of vision, but it did not survive the introduction by Zoellner and Huggins of the wide slit method, and apparently was not tried for observing the sun's disk.

Many years ago I made some preliminary trials of the oscillating slit method with the 30-foot spectroscope and 60-foot tower telescope on Mount Wilson. I have only recently found opportunity to develop a satisfactory instrument based on this principle with which I have now secured good visual observations of both bright and dark flocculi.

An image of the sun two inches in diameter, given by a cœlostat and a 12-inch objective formerly belonging to the Kenwood Observatory,[2] was observed with a grating spectroscope mounted horizontally. In this instrument the light passing through the slit falls on a 6-inch concave mirror of 13-feet focal length, which returns a parallel beam to a point just below the slit, where a 6-inch plane grating is mounted. This sends the diffracted beam to a second 6-inch concave mirror, supported below the collimating mirror, which forms an image of the spectrum in the same plane as the first slit, and immediately below it. A fixed second slit at this point permits any part of the spectrum to be isolated. The grating was ruled by Jacomini with about 15,000 lines to the inch on the ruling machine of the Mount Wilson Observatory, with a diamond ground after Anderson's formula so as to give great brightness at the red end of the first order spectrum. The definition is perfect, and the brightness near Hα remarkable, as the attempt to concentrate most of the light in one spectrum and to favour the red end proved successful.

Suppose the first and second slits to be carried at opposite ends of a brass bar, mounted on a bearing half-way between them and thus free to revolve about this centre. Place the bar vertical, and turn the grating until the Hα line in the bright first order is bisected by the second slit. With the optical arrangement employed, a small displacement of the first slit to the right causes an exactly equal displacement of the Hα line to the left. Thus if the bar is oscillated back and forth by means of a small electric motor, a monochromatic image of the sun will be seen through a low power positive eyepiece focussed on the second slit.

This arrangement serves very well for the observation of prominences at the limb, where they can be seen at their full height with slits of moderate width. It also shows exceptionally bright or dark flocculi on the disk, though the slits must be narrower in order to give sufficient purity and reduce the brightness of the continuous spectrum. For flocculi of ordinary intensity the best results have been obtained with the aid of multiple slits, five at each end of the bar, 0·003 inch wide and 0·08 inch apart. A fixed slit, slightly less than 0·08 inch wide, must be used behind the upper slits, to prevent the formation of overlapping spectra. Two complete oscillations of the bar per second, corresponding to twenty illuminations of the retina, give a sufficiently steady image. A rotating disk, carrying a large number of radial slits, is in some respects a more satisfactory device for the same purpose.

This instrument, which may appropriately be called a spectrohelioscope, should prove a valuable auxiliary of the spectroheliograph in several kinds of work. It will permit the rapidly changing forms of eruptions on the disk to be followed visually, and be of special service in deciphering the curious differences of structure sometimes found on photographs of flocculi taken simultaneously with the opposite edges of Hα. As the oscillating bar can be moved toward red or violet by a micrometer screw while observations are being made, the possibility of passing instantly from one edge of the line to the other should assist in the interpretation of the spectroheliograph results.

[1] Communicated to the National Academy of Sciences, Washington, on July 7, and published in the Proceedings of the Academy for August, vol. 10, No. 8, 1924.

[2] Kindly loaned me by Prof. Frost. The apparatus was set up temporarily in my garden at South Pasadena.

Oil-Cracking.

A PAPER on "Recent Development in the Art of Cracking," by A. E. Dunstan and R. Pilkethley, was read before the Institution of Petroleum Technologists on October 7. The object of "cracking" is to obtain a lighter constituent from hydrocarbon oils by temperature treatment, under suitable conditions. During the last few years there has been little advance in our knowledge of cracking from the chemical point of view, and most of the problems connected with it have been more of an engineering quality. Very little work has been done on the examination of the residues left after the cracked gasoline has been removed from the synthetic crude oil.

Vapour phase processes working at atmospheric pressure have not been very successful; most of the processes developed worked under 300 to 400 lb. per sq. in. pressure, and no particular advantage in the use of extremely high pressures is apparent. The Bergius process was at first directed towards the production of artificial coal from wood, cellulose, etc., and a black powder containing 84 per cent. of carbon was obtained at 349° under 160 atm. pressure. This was susceptible of hydrogenation by heating to 400° in the presence of hydrogen for some hours, and 70 per cent. of the product was soluble in benzene. In later experiments, natural coal mixed with oil was converted up to a 90 per cent. yield of oil, yielding fractions suitable for use as fuel oil.

The experiments of the present authors throw some doubt on the hydrogenation of the liquid products. Processes for cracking in the vapour phase, *e.g.* the Ramage plant, in which the vapour of the hydrocarbon is passed over heated iron oxide, were described. The Dubbs process is two-stage, the oil being cracked in tubes in the liquid state, then passed to a reaction chamber where carbon is deposited, and the vapours then passed to a dephlegmator which separates heavy oil from lighter cracked vapours. The pressure is about 150 lb. per sq. in., and the process is commercially successful. The Cross process differs from the Dubbs process in the form of the apparatus, and the pressure and temperature conditions.

The Auld, Dunstan and Hering process is described. It is substantially a liquid phase operation throughout, the pressure being sufficiently high to maintain all but the lightest products liquid (25-30 atm.); the yield of light spirit is restricted for definite reasons, the temperature range is definitely fixed for each oil, and the rate of flow is controlled according to the temperature. The oil is first carefully heated to below the optimum temperature, quickly raised above this temperature, and then allowed a certain time of contact in a reaction vessel, where carbon is deposited. The cracked oil is drawn off from the highest point of the vessel, condensed or dephlegmated, and discharged into a gas separator. Experimental plant recently used is also described, and the important problem of refining, including distillation over bauxite or activated carbon, is discussed.

University and Educational Intelligence.

CAMBRIDGE.—Mrs. Marshall, widow of the late Prof. Alfred Marshall, has offered to the university a most valuable selection of books from her husband's library for the use of students in economics, together with 1000*l.* to be used in expenses connected with the books and with any arrangements which may be made for facilitating economic research.

Dr. Dollo has been appointed to represent the university at the fiftieth anniversary of the founding of the École Polytechnique of the University of Brussels. Prof. A. C. Seward has been appointed as a Trustee of the Percy Sladen Memorial Fund. Mr. T. A. Carroll, Sidney Sussex College, has been appointed assistant director of the Solar Physics Observatory in succession to Mr. E. A. Milne, who has resigned on being appointed to the Beyer chair of applied mathematics at the University of Manchester.

At Emmanuel College the following have been elected to Research Studentships: G. A. Reay, University of Aberdeen (biochemistry); W. W. Grave (Romance literature); and P. A. Taylor (mathematics).

CORK.—Applications are invited for the professorship of chemistry at University College. Particulars are to be had from the secretary.

LONDON.—Birkbeck College, which celebrated its centenary last year, announces in its calendar for 1924–25 that great development in accommodation and in facilities for study in the college is probable in the near future. Appended to the calendar is an imposing list of original publications by members of the staff and students, chiefly in chemistry, physics, zoology, geology, classics, and modern languages.

Prof. S. L. Loney has been elected chairman of Convocation, and Sir Josiah Stamp representative on the Senate of the Registered Graduates in Science.

DR. A. T. DE MOUILPIED, of the British Dyestuffs Corporation, has been appointed professor of science at the Royal Military Academy, Woolwich, in succession to Prof. J. Young, as from January 29 next.

APPLICATIONS are invited for the headship of the chemical department of the Midland Agricultural and Dairy College, Sutton Bonington, Loughborough. Particulars of the appointment may be had from the principal.

A LECTURER in agricultural chemistry is required at the Cheshire School of Agriculture, Reaseheath, Nantwich. Applications, upon a prescribed form, must be sent to reach the principal of the school by November 7 at latest.

DR. ALEX HILL, secretary of the Universities Bureau of the British Empire, 50 Russell Square, London, W.C.1, informs us that the six great lines engaged in the passenger service to Australia and New Zealand have agreed to grant eight free first-class return tickets, yearly, to University graduates desirous of studying problems connected with the development of the resources of the Dominions, or of holding temporary teaching posts. The selection of the recipients is to rest with a committee of the Universities Bureau.

THE Senate of the University of Sydney has resolved on the appointment of a chief executive paid officer, with the title of Vice-Chancellor, to take the place of the Warden and Registrar, Mr. H. E. Barff, who has just retired. The necessary legislation is being drafted, and in the meanwhile Prof. MacCallum has been asked to undertake the duties of Warden temporarily. Prof. J. I. Hunter and Dr. N. D. Royle have been invited to deliver the Doctor John B. Murphy oration in surgery at the meeting of the American College of Surgeons to be held in New York on October 20.

THE following candidates have been nominated for election as Parliamentary representatives of the universities of Great Britain and Northern Ireland:—CAMBRIDGE (2)—Mr. James Butler (Ind.), Sir Geoffrey Butler (U.), and Mr. J. F. P. Rawlinson (U.). LONDON (1)—Sir John Rose Bradford (U.), Dr. F. G. Bushnell (Lab.), Dr. E. G. Graham Little (Ind.), and Prof. A. F. Pollard (Lib.). OXFORD (2)—Lord Hugh Cecil

(U.), Prof. Gilbert Murray (Ind.), Sir Charles Oman (U.). SCOTLAND (3)—Sir George Berry (U.), Mr. D. M. Cowan (L.), Sir Henry Craik (U.), Rev. J. M. Munro (Lab.). WALES (1)—Mr. G. M. L. Davies (Lab.), Capt. E. Evans (L.). QUEEN'S, BELFAST (1)—Col. T. Sinclair (U.).

THE Municipal College of Technology, Manchester, announces reductions in fees for degree and certificate courses amounting to 10 per cent. in favour of residents in Lancashire and Cheshire (who were already favoured to the extent of 16 per cent.), and 16 per cent. in favour of students from other parts of the British Empire. According to the Calendar for 1924–25, courses of post-graduation and specialised study and research are offered in mechanical engineering (including hydraulic experimental work, motor-car engineering, and eight other subjects), electrical engineering, municipal and sanitary engineering, applied chemistry (including textile fibres, paper manufacture, metallurgy, india-rubber, brewing, coal-tar and dyestuffs, and photography), textile industries, applied physics, and mining engineering. Last year, ten research scholarships of 100*l*. each were awarded by the College. Among other technical college calendars recently received are those of Loughborough College (departments of mechanical, civil, electrical, automobile, and commercial engineering, pure and applied sciences including chemical technology, extra-mural adult education, and school of industrial and fine art) and the Battersea Polytechnic (engineering, pure and applied mathematics, physics, chemistry and technological chemistry, photography, hygiene and public health, domestic science, and arts and crafts). The subjects of the Polytechnic's technological courses include oil industries, paper industries, and flour-milling.

THE Vice-Chancellor of Oxford has contributed to the October number of the *Empire Review* an article on "Oxford and the Empire." Starting with the great Elizabethans, Sir Humphrey Gilbert of Christ Church, his half-brother Sir Walter Raleigh of Oriel College, and Richard Hakluyt of Christ Church, he gives a list of Oxford men who have during the last four hundred years played distinguished parts in building up the British Empire or the ideas on which it is based, or in its governance. He points out that of the twenty-five governors-general of India from Warren Hastings to Lord Curzon, fourteen were university men; and of these, twelve were educated at Oxford, nine of them at Christ Church. He discusses the features of university life which favour the development of those qualities which go to make good administrators, and deplores the fact that the Indian Civil Service no longer attracts Oxford graduates. Of the Rhodes scholars, he singles out for mention the late Sydney Fairbanks of Rhodesia, who chose an Oxford career especially with the view of developing his own plans of child emigration. The influence on Oxford of Rhodes scholars from the overseas Dominions and the influence of their Oxford training on their subsequent careers is a theme deserving more attention than it has hitherto received. It is to be hoped that the Vice-Chancellor's article may lead to studies of this theme and also of the relations between other universities and the Empire. As Prof. Newton says in his new book, "The Universities and Educational Systems of the Empire," every university is, in a sense, imperial, but the peculiarly imperial university is one that by long prescription, by eminent advantages of situation, and by the labours of a line of great investigators, has acquired prestige and reputation as a *studium generale*.

Early Science at the Royal Society.

October 27, 1670. There was read a Latin letter from Signor Montanari of Bologna, expressing the singular esteem which he had of their institution. —Mr. Oldenburg produced another Latin letter from Erasmus Bartholinus, M.D. of Copenhagen, giving notice of a certain transparent stone, a kind of selenites, sent out of Iceland, and having different positions, a double, quadruple, and sextupline refraction; as also an electric virtue.

October 28, 1663. At a meeting of the Society the president reported to them, that because the stationers and printers are of one and the same company, and may, by the concession of both sides, practise both trades promiscuously, the Society might choose a stationer for their printer without violation to their charter, which gives them power to choose printers. Whereupon Mr. John Martyn and Mr. James Allestry being recommended, it was put to the question, whether it should be the question, that the office of printer to the Royal Society should be conferred jointly; and it was carried in the affirmative; after which those two persons were put to the ballot, and chosen.

1669. Mr. Oldenburg mentioned that Dr. Wren desired to borrow that engine of his, in order to make a scheme and description thereof for the satisfaction of Mons. Huygens, who, though he had much applauded that invention, and the demonstration of it, yet had made some objection against its practicableness.

October 29, 1662. Dr. Wilkins and Dr. Goddard gave an account of the experiment which had been made of a lamp burning under water in a vessel of four gallons, the ellychnium being one single thread of cotton, and the lamp wholly under water: the flame lasted eleven minutes.—They were desired to repeat the experiment several times; as also to try it with some live creatures.

October 30, 1672. An account being demanded of what trials had been made for the improvement of the reflecting telescope of Mr. Newton, Mr. Hooke said, that hitherto he had wanted a mould of a sufficient bigness for a speculum, designed by him of fifteen inches diameter, for a tube of ten feet long; but that he hoped to have, soon, such a mould cast, wherein a speculum of that bigness might be well wrought and polished.

1674. The form of the summons to the Society for returning to their weekly meetings being read again, it was thought fit to omit the names of the persons who were to entertain the Society, and to let it be as follows:—these are to give notice that the Royal Society intends to return to their public meetings on Thursday, being the 12th of this instant November 1674, in Gresham College; at three of the clock; at which time and the following days of their meetings the company will be entertained with experimental exercises, to be performed by several eminent members of the same, in order to a more vigorous prosecution of the ends of their institution.

October 31, 1667. Mr. Evelyn presented the Society with his wooden tables, having the veins and arteries of the human body fixed on them.—A report being made of Dr. Allen's scrupling to try the experiment of transfusion upon any of the mad people in Bethlem-hospital, it was ordered that he should be desired by Mr. Hooke to give a meeting at Sir George Ent's house on the Monday following to some of the physicians of the Society, as Sir Theodore de Vaux, Dr. Clarke, Dr. Lower, Dr. Balle, and Dr. King to consider together, how this experiment might be most conveniently and safely tried.

Societies and Academies.

LONDON.

Optical Society, October 9.—E. T. **Hanson**: Some problems in the theory of optical diffraction. A semi-infinite plane may be looked upon as a wedge the internal angle of which is zero. The application of Kirchoff's formula in the latter case is considerably extended, it being shown that, through a region of not too small dimensions comprising the whole of the boundary of the geometrical shadow, the solution obtained is identical with the accurate solution. An expression is found for a plane wave incident at any angle upon a semi-infinite screen. An approximate expression is also found for the disturbance distributed over a straight slit due to a wave incident normally. Kirchoff's formula has been applied, apparently for the first time, to an area of disturbance which is non-uniform.—W. M. **Hampton**: The annealing and re-annealing of glass. Relations connecting the strains present when cooling commences, strain due to gradient, and strain present after cooling, are obtained and the equations are applied to the case of slabs. The considerations affecting the temperature and conditions of annealing are discussed and tables giving annealing temperature, annealing time and rate of cooling for various kinds of glass are included.

PARIS.

Academy of Sciences, September 22.—M. A. d'Arsonval in the chair.—Paul **Appell**: The order of a non-holonomial system.—E. **Mathias**: The theory of the lightning flash.—Georges J. **Rémoundos**: Couples of functions of one variable corresponding to the points of an algebraic curve of genus higher than unity and on a generalisation of a theorem of M. Picard.—Benjamin **Jekhowsky**: The elements of the planet Algiers M = 1924 PQ.—E. M. **Antoniadi**: The retarded decrease of the southern snows of Mars and its coincidence with the solar minimum.—E. **Brylinski**: On a possible thermal perturbation in Michelson's experiment.—Nicolas **Perrakis**: A remarkable property of the first differential of the Trouton-de Forcrand law and on the probable value of the electronic entropy.—T. **Batuecas**: Revision of the compressibility of methyl oxide and the molecular weight of this gas. The pressures exerted by a given mass of methyl ether were measured at five volumes, the results being expressed in the form $pv = a - bp$. From the density of the normal litre previously determined and the coefficient obtained from these experiments, the figure 11·999 is deduced for the atomic weight of carbon. This result proves that the law of limiting densities is rigorously applicable in all cases, provided that the variation of the compressibility with the pressure is taken into account.—J. **Locoste**: Microseismic movements at Strasbourg. It is shown that there is a relation between the microseismic movements and meteorological conditions (variations of barometer and of wind velocity).—Alfred **Carpentier**: The fructifications of the Pteridospermeæ from the Westphalian of the north of France.—**Bezssonoff**: The colour reactions of the liposoluble factors. A study of the colour reactions produced with phosphomolybdotungstic acid.—F. **Vincens**: Possibility of the transmission of pernicious *loque* of bees by the grubs of *Galleria mellonella*.—E. **Lesné**, R. **Turpin**, and Ch. O. **Guillaumin**: Some physico-chemical variations of the plasma during conditions favouring convulsions in the child.—Marc **Romieu**: Microchemical studies on the granulations of the eosin-fixing leucocytes in man.

ROME.

Royal Academy of the Lincei; papers submitted during the Vacation, 1924.—G. **Ricci-Curbastro**: Varieties in equal principal invariants.—M. **La Rosa**: The Doppler effect and the ballistic principle in relation to the velocity of light. A reply to a note by W. De Sitter.—A. **Angeli**: Constitution of santonin. The compounds resulting from the gradual decomposition of santonin by means of dilute aqueous permanganate are described.—Ferruccio **Zambonini**: Atomic structure according to Bohr, and the isomorphogenism of metals of the rare earths with those of the calcium group.—Giuseppe **De Lorenzo**: Coal in the mesozoic strata of Lagonegro in Basilicata.—P. Vinassa **de Regny**: The mesozoic region of Central Dancalia.—Francesco **Tricomi**: Numerical resolution of Fredholm's integral equations.—O. **Mayer**: Transformations between linear elements of two surfaces which retain Levi-Civita's parallelism.—G. **Cassinis**: Gravimetric comparison of Rome with Bologna and Padua. If the value of g is taken as 980·367 cm. at Rome, the corresponding values at the University of Bologna and at the Royal Astronomical Observatory at Padua are respectively 980·455 and 980·659 cm.—Franco **Rasetti**: Effect of the magnetic field on the polarisation of resonance radiation. The results of experiments with mercury vapour are described, and the known facts are shown to be capable of simple correlation and to be intimately connected with the Zeeman effect and with the orientation of the atoms in the magnetic field.—A. **Cruto**: Chemical constitution of insulin. The empirical formula of highly purified insulin confirms the classification of this substance with the proteins, and, in conjunction with its reactions, indicates for it a position among either the globulins or the albumoses.—G. **Mazzetti**: Thermal dissociation of certain carbonates. The means adopted in the study of these dissociations consisted of thermal analysis and of an arrangement permitting the curve connecting the temperature with the diminution in weight to be traced directly on a photographic plate. Certain of the values obtained for the temperature of initial decomposition differ from those given by previous investigators.—V. **Tognazzi**: Chalkones and hydrochalkones. In alcoholic solution and in the presence of platinum black, each of the chalkones examined absorbs two atoms of hydrogen, yielding the hydrochalkone.—Carlo **Cappelletti**: The vegetation of resins. The fungi found in resins are nourished by the impurities always extruded with the resins and are able to tolerate oil of turpentine in relatively high proportions. In a moist climate the slow drying of the resin encourages the establishment of the fungoid vegetation, whereas in a dry climate the resin undergoes rapid superficial drying, invasion of the mycelia being thus checked.—P. **Pasquini**: Further knowledge of the pelagic fauna of Lake Trasimeno.—U. **Pierantoni**: New observations on luminescence and symbiosis. III. The luminous organ of *Heteroteuthis dispar*.—M. **Sella**: Observations on the innervation of the myotome of the murenoids and other Teleostei.

CAPE TOWN.

Royal Society of South Africa, August 20.—Dr. A. Ogg, president, in the chair.—S. H. **Haughton**: A bibliographic list of pre-Stormberg Karoo reptilia with a table of horizons.—G. W. **Cox**: On the periodicity of rainfall. A cursory inspection of any table of annual rainfall values discloses irregularities which suggest the results of pure chance. A vital question in long range weather forecasting is whether the values of data follow any law of succession separable from the law of chance. This paper discusses the existence of a cycle in rainfall.

Official Publications Received.

Bureau of Education, India. Pamphlet No. 18: Conference of Indian Universities held in May 1924 at Simla. Pp. viii+79. (Calcutta: Central Publication Branch.) 7 annas; 8d.

Agricultural Research Institute, Pusa. Bulletin No. 154: The Bionomics of the Sarcoptic Mange Parasite of the Buffalo, with some Observations concerning the relative Power of Resistance to Adverse Conditions of the different stages of the Acarus and of its Egg. By T. M. Timoney. Pp. 180-200. (Calcutta: Central Publication Branch.) 2 annas.

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 25: Size in relation to Internal Morphology. No. 1: Distribution of the Xylem in the Vascular System of Psilotum, Tmesipteris, and Lycopodium. By Claude W. Wardlaw. Pp. 503-532. 4s. Vol. 53, Part 3, No. 26: Observations on the Early Development of the Human Embryo. By Prof. Thomas H. Bryce. Pp. 533-567+9 plates. 7s. 6d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Travaux du Laboratoire de Psychologie expérimentale de l'Université de Cracovie. Édités par W. Heinrich. Pp. iv+391. (Cracovie: Académie Polonaise des Sciences et de Lettres; Paris: Félix Alcan.) 25 francs.

Memoirs of the Indian Museum. Vol. 5: Fauna of the Chilka Lake. No. 12: Crustacea Copepoda, by Major R. B. Seymour Sewell; Mollusca Gastropoda (revision) by the late Dr. N. Annandale; Tanaidacea and Isopoda, by Prof. Charles Chilton. Pp. 771-896+plates 44-60. (Calcutta: Zoological Survey of India.) 10 rupees.

Report of the Aeronautical Research Institute, Tōkyō Imperial University. No. 7: Über die Mechanismen der Zyklonen und Antizyklonen. Von Tatuo Kobayasi. Pp. 187-212. (Tōkyō: Maruzen Kabushiki-Kaisha.) 0.700 Yen.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 52: The Effect of the Summer Fallow upon Soil Protozoa in Egypt. By Dr. E. McKenzie Taylor and A. Chamley Burns. Pp. 10. (Cairo: Government Press.) 5 P.T.

Bulletin of the American Museum of Natural History. Vol. 51, Art. 5: Basin Structures in Mongolia. By Charles P. Berkey and Frederick K. Morris. Pp. 103-127. (New York.)

Proceedings of the Cambridge Philosophical Society. Vol. 22, Part 3. September 20th. Pp. 201-480. (Cambridge: At the University Press.) 10s. net.

Report of Technical Conference held under the Auspices of the Rubber Growers' Association, Inc., and the Research Association of British Rubber and Tyre Manufacturers, London, Friday, 18th July 1924. Pp. 44. (Croydon: Research Association of British Rubber and Tyre Manufacturers, 105 Lansdowne Road.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1425: The Tobacco Flea-Beetle in the dark Fire-cured Tobacco District of Kentucky and Tennessee. By A. C. Morgan and J. U. Gilmore. Pp. 12. (Washington: Government Printing Office.) 5 cents.

Koninklijk Nederlandsch Meteorologisch Instituut. No. 102, Mededeelingen en Verhandelingen. 28: De Stoomwegen van Ceylon naar de Golf van Aden en den Zuidwestmoesson. By P. M. Van Riel. Pp. 20. 0.35 fl. 29a: Klimatologie van den Indischen Ocean. (With English Summaries.) By P. H. Gallé. Pp. 87. 1.50 fl. ('s-Gravenhage: Algemeene Landsdrukkerij.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 108, Seismische Registrierungen in De Bilt. 9, 1921. Pp. xiv+44. (Utrecht: Kemink en Zoon.) 0.80 fl.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 4: A Type Rural High School—Mount Vernon Union High School, Skagit County, Washington. By C. A. Nelson and E. E. Windes. Pp. iii+36. Bulletin, 1924, No. 23: Government Publications useful to Teachers. Compiled by Eustace E. Windes. Pp. 34. (Washington: Government Printing Office.) 10 cents each.

British Museum (Natural History). British Butterflies. Series No. 2, Set E19. 5 cards in colour. Series No. 3, Set E20. 5 cards in colour. Series No. 4, Set E21. 5 cards in colour. Series No. 5, Set E22. 5 cards in colour. Series No. 6, Set E23. 5 cards in colour. Series No. 7, Set E24. 5 cards in colour. Exotic Moths. Series No. 4, Set E25. 5 cards in colour. Series No. 5, Set E26. 5 cards in colour. Series No. 6, Set E27. 5 cards in colour. British Moths. Series No 2, Set E28. 5 cards in colour. (London: British Museum (Natural History).) 1s. each set.

Canada. Department of Mines: Geological Survey. Summary Report, 1923, Part A. Pp. 114A. Memoir 139, No. 119 Geological Series: Coquihalla Area, British Columbia. By C. E. Cairnes. Pp. 187. (Ottawa: F. A. Acland.)

Diary of Societies.

MONDAY, OCTOBER 27.

CAMBRIDGE PHILOSOPHICAL SOCIETY (Annual General Meeting), at 4.30.—J. T. Saunders: The Hydrogen in Concentration of the Waters of Lake Lucerne.—J. Gray: The Process of Cell Division in the Eggs of Echinoderms.—V. Nath: Oogenesis of Lithobius.—*By title only*:—Dr. H. Singh Pruthi: Studies on Insect Metamorphosis—1. Prothetely in Mealworms (*Tenebrio molitor*) and other Insects. Effects of Different Temperatures.—H. Munro Fox: Chlorocruorin.—C. G. F. James: Characteristics of Complexes of Conics in Space of Four Dimensions.—T. M. Cherry: Integrals developable about a Singular Point of a Hamiltonian System of Differential Equations.—R. A. R. Tricker: A Helical Method of focussing β-rays.—D. R. Hartree: Some Methods of estimating the Successive Ionisation Potentials of any Element.—Sir Joseph Larmor: Why Wireless Electric Waves can bend round the Earth.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. F. O. Bower: Presidential Address.

INSTITUTE OF ACTUARIES, at 5.—A. D. Besant: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W. B. Woodhouse and others: Discussion on The Interconnexion of Power Stations.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—W. T. Maccall: Chairman's Address.

ROYAL SOCIETY OF MEDICINE (Odontoiogy Section), at 8.—J. G. Turner: Presidential Address.—E. D. D. Davis: Some Points in the Pathology, Diagnosis, and Treatment of Disease of the Maxillary Antrum.

MEDICAL SOCIETY OF LONDON, at 8.30.—Clinical Evening.

TUESDAY, OCTOBER 28.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin), at 4.15.—H. H. Jeffcott: The Determination of the most Economic Size of Pipe Line for Water Power Installations.—Dr. W. R. G. Atkins and G. T. Harris: Seasonal Changes in the Water and Heleoplankton of Fresh Water Ponds.—K. C. Bailey: The Synthesis of Urea from Carbon Dioxide and Ammonia under Atmospheric Pressure.—Miss S. D. King: Oogenesis in *Lithobius fortificatus*.—A. Subba Rass, F. W. R. Brambell, and Prof. J. B. Gatenby: Observations on the Golgi Bodies in the Living Cell.

INSTITUTION OF CIVIL ENGINEERS, at 6.—E. Crammond: The Economic Position of Great Britain.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 83 Pall Mall) (Informal Meeting), at 7.—Demonstration and Discussion of Devices connected with Cars not yet on the Market.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Special General Meeting (Members only).

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Discussion on Paper by A. J. T. Taylor: Pulverised Fuel in its Commercial Aspect.—E. F. Spanner: A Proposed Form of Bow Construction.

WEDNESDAY, OCTOBER 29.

INSTITUTE OF PHYSICS (at Institution of Electrical Engineers), at 5 30.—Sir Oliver Lodge: Electrical Precipitation ("Physics in Industry," No. vii.).

THURSDAY, OCTOBER 30.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major J. S. Buchanan: The R.Ae.C. Light Aeroplane Competitions.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section and Faraday Society) (at University College, Nottingham), at 5.30.—Dr. W. L. Balls and others: Discussion on Textiles.

CHILD-STUDY SOCIETY, at 6.—Dr. H. Y. Trotter: The Teaching of Music.

SOCIETY OF DYERS AND COLOURISTS (Midland Section) (at University College, Nottingham).—N. C. Lamb: The Dyeing of Leather.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.—J. E. Anderson: Presidential Address.—Sir Henry Fowler: Solid Crank Axles for Locomotives.

FRIDAY, OCTOBER 31.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Anatomy and Malformations of the Heart—(3) Specimens illustrating Points in the Applied Anatomy of the Human Heart.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Engineering Novelties at the British Empire Exhibition.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Section) (at Leeds).—Prof. W. T. David: Heat Loss in Gas-Engines.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—L. Eveleigh: Professional Secrets and Trick Kinematography.—J. Noble: Out of the Ink Pot and how it is done.

JUNIOR INSTITUTION OF ENGINEERS (at 39 Victoria Street), at 7.30.—H. J. N. Riddle: Audio-frequency Transformers.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Institution, Middlesbrough), at 7.30.—L. W. E. Rowbotham: Chairman's Address.

SATURDAY, NOVEMBER 1.

GILBERT WHITE FELLOWSHIP (at Queen Square, W.C.), at 3.—Sir A. Daniel Hall: The Countryside in English Literature (Presidential Address).

PUBLIC LECTURES.

SATURDAY, OCTOBER 25.

HORNIMAN MUSEUM (Forest Hill). at 3.30.—F. Balfour-Browne: Social Life amongst Insects—(1) Ants, Bees, and Wasps.

MONDAY, OCTOBER 27.

UNIVERSITY COLLEGE, at 5.30.—Sir Mark Hunter: The History of English Pronunciation.

WEDNESDAY, OCTOBER 29.

UNIVERSITY COLLEGE, at 5.30.—L. Newcombe: University College Library and Modern University Libraries.

FRIDAY, OCTOBER 31.

UNIVERSITY COLLEGE, at 5.15.—Lt.-Comdr. A. S. Elwell-Sutton: China, her People and the Present Situation.

SATURDAY, NOVEMBER 1.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Some Famous Pharaohs.