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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Scientific Worthies.

XLIII.—IVAN PETROVITCH PAVLOV.

THE eminent physiologist, whose portrait is published to-day in continuation of the NATURE series of Scientific Worthies, was born on September 14, 1849, in the district of Rjäsan in Russia. He was the son of the village priest. After receiving some education at a theological seminary, he determined to devote himself to science and entered the University of St. Petersburg. On the completion of his course in general science, he took the medical course at the Military Medical Academy, receiving his qualification to practise in 1879. At that time Botkin, the clinician, maintained several younger men as scientific assistants to carry on research in connexion with his wards, and Pavlov, after qualification, became his assistant, with special charge of the work involving animal experimentation. In 1883 he obtained the M.D. of St. Petersburg, and in 1884 was appointed privat-dozent in physiology. Immediately afterwards, he went for two years to Germany to work under Ludwig and under Heidenhain. In 1890 the Institute of Experimental Medicine was built at the cost of Prince Oldenburg, von Anrep being appointed its first director, and in 1891 Pavlov became director of the physiological department of the Institute. In 1897 he was called to the professorship of physiology in the Military Medical Academy, without, however, giving up his post in the Institute of Experimental Medicine, and in 1907 he became one of the four scientific members of the St. Petersburg Academy and obtained in this way another laboratory under his charge. His work from this time forward, therefore, was carried on in three laboratories, his own personal experiments, however, being confined to the Institute of Experimental Medicine, the other two laboratories being in charge of assistants, though the work at all three places was inspired directly by Pavlov and subject to his continual oversight and criticism.

Pavlov married quite young, his wife being a teacher in a school and herself the daughter of a village priest. He has had four children, one of whom is a well-known physicist who has worked in Cambridge under Sir Joseph Thomson and is now professor of physics in Leningrad.

Pavlov's scientific work falls easily into three well-defined chapters, though there is a certain leading idea which has guided him throughout and characterises all the researches for which he has been responsible. He set himself from the beginning to elaborate the analytic method of research. Each function of the body has to be studied in relation to other functions as well as to external conditions, and the exact part played by each condition determined by artificial removal or arousal of the condition *while keeping the other conditions constant.* Up to Pavlov's time the necessity for this last precaution had not been properly appreciated or systematically carried out. Physiologists had been content to study functions in isolated organs or in animals in a profoundly abnormal condition, either through the action of anæsthetics or under the effects of discomfort or pain. Pavlov realised that these disturbing factors, namely, anæsthetics, pain and discomfort, must be eliminated before the part played by excitation of a nerve, for example, under normal conditions could be appreciated, or proper value given to the results of operative procedure.

We see the beginning of these ideas in the first chapter of Pavlov's scientific activities, those connected with the physiology of the circulation. The first papers published by him in German appeared in 1878–1879 and dealt with the normal regulation of the blood pressure in the dog. In these experiments, Pavlov trained a dog to allow the insertion of a cannula in a small superficial artery on the inner side of the knee-joint and to remain quiet while the blood pressure was recorded. In such an animal he was able to study the effects of digestion as well as of drinking large quantities of fluid in the form of broth. He found that neither of these procedures produced any change in blood pressure amounting to more than about 10 mm. of mercury. In 1887 he published two papers on the efferent nerves of the heart, the first based on work carried out in St. Petersburg, while in the second paper he described the results of testing his previous findings with the use of Stolnikow's apparatus for measuring the output of the isolated heart. This research was carried out while he was studying in Ludwig's laboratory.

The work, however, for which Pavlov is best known is that connected with the physiology of digestion. Here the introduction of new methods devised to fulfil the conditions laid down by him at the beginning of his career enabled him to rewrite this chapter in physiology. At the present time our whole idea of the course of digestion is based upon Pavlov's discoveries. This work would have been impossible but for Pavlov's marvellous skill as an operator. Already in 1879 he had published three papers on the pancreatic secretion, and one of these described a new method which he had elaborated for making a pancreatic fistula, but from 1888 to 1900 all his activities were devoted to the problems of digestion. In 1888 he showed that the vagus nerve was the secretory nerve to the pancreas, and also was able to explain why previous observers had failed to obtain any results from stimulating this nerve. In 1889 one of his pupils published a preliminary note in the *Centralblatt für Physiologie* on the secretion of the gastric juice.

It is in this note that we first find a description of Pavlov's method for obtaining pure gastric juice. The animal was provided with fistulous openings into the stomach and also into the œsophagus. Such an animal had to be kept alive and in good condition by the introduction of food through the lower end of the œsophagus or directly into the stomach. It was essential, according to the rules laid down by Pavlov, that the animal should be kept in good condition, free from pain or even from discomfort. After such an operation these objects can only be attained by devoting extreme care to feeding the animals. At that time there were no proper facilities for the care of animals, and this work could not be entrusted to an ordinary laboratory attendant. Pavlov, therefore, after operating on his dogs, took them home, and here in his small flat they were looked after by his wife, with the children.

The success of Pavlov's experiments was entirely due to the devoted care which was given to the animals. In a dog provided with an œsophageal and a gastric fistula Pavlov found that, within a few minutes of giving the animal food, there was a copious flow of juice through the gastric fistula. This was known as "sham feeding," and the secretion was proved by him to be due to the effect of appetite and was therefore named by him "psychical secretion." It could be aroused not only by eating but also by the mere sight of food, though it ceased as soon as the animal realised that the food was not going to be given to it. Pavlov proved also that the efferent channel for the psychical reflex was by the vagus nerves and that the secretion was stopped by section of the vagus nerves and was aroused by artificial stimulation of the peripheral end of a cut vagus nerve.

From 1892 to 1897 a whole array of papers on the physiology of digestion appeared in the *Archives des Sciences Biologiques,* so that Pavlov's discoveries became known to his colleagues in other countries. In 1897 a collected account of his work was brought out in German and in French under the title "Die Arbeit der Verdauungsdrüsen." A little time later an English translation appeared from the German edition by Prof. W. H. Thompson. In 1904 Pavlov was awarded the Nobel Prize for medicine for his work on the physiology of digestion. By this time, however, Pavlov's methods had become widely known through the agency of his pupils, many of whom had acquired sufficient operative skill to carry out the difficult operations which had previously depended on Pavlov himself, so that the work could be continued on the lines laid down in Pavlov's laboratory. At the date of the award of the Nobel Prize, Pavlov had practically given up a direct personal interest in the subject of digestion and had taken up another subject.

Hitherto, our methods of investigating the functions of the cerebral hemispheres have been extremely unsatisfactory. We may study the effects of removal or excitation of definite areas in the cortex, but the results of such experiments have given rise to conflicting opinions as to their significance. We know, for example, that in most mammals all the apparatus necessary for immediate motor reactions is contained in the parts below the hemispheres, and it is difficult to judge from the presence or absence of a response to some sensory stimulation after removal of portions of the cortex whether the cortical deficiency is really responsible for the effects, if any, observed. More stress has been laid, therefore, on observations on man, where lesions have been produced in the cortex by disease or injury. Here, however, there is a tendency to abandon the pure physiological method, and in our arguments we are apt to jump continually from the objective to the subjective method and vice versa.

Physiology is the objective examination and analysis of the behaviour of an animal under all manner of conditions. Up to the time when Pavlov began his researches, we lacked such objective physiological methods as would do for the analysis of the functions of the cortex the same services that had been rendered by physiological method in the hands of Sherrington for the analysis of the spinal reflex functions, or which have recently been used by Magnus and others in the investigation of the manner in which equilibrium is maintained or restored. We know that the cerebral cortex is what has been called the educatable part of the central nervous system: it is responsible for reactions which have been learnt in the course of the individual's existence. In the higher animals, especially in man, these learnt reactions overlie and take precedence of most of the immediate reflexes carried out by the spinal cord and brain stem, so that almost the whole of a man's behaviour throughout his adult life is carried out by a series of reactions to the environment for which the cortex is primarily responsible. An analysis of the manner in which this complex never-ending series of reactions is built up so as to form an individual with his peculiar reactions, must begin with the simplest.

Pavlov conceived the ingenious idea of using the appetite reactions, with which his previous twenty years' work had made him so familiar, as an objective sign of cortical reactions. It is well known that introducing acid or other gustatory substances into the mouth of a dog evokes a flow of saliva, and the intensity of the reaction can be measured by providing the animal with a salivary fistula and counting the drops or measuring the amount of saliva which is secreted in response to a given stimulus. Such a reaction is called by Pavlov an *unconditioned reflex*. If, however, some other kind of stimulus, for example, ringing a bell, be associated for some time—weeks or even days—with the presentation of food or the introduction of acid into the mouth, the associated stimulus after a time is sufficient to evoke a flow of saliva without the presentation of food. This reaction was called by Pavlov a *conditioned reflex*. It is dependent on the laying down—the "education"—of new paths in the cortex. This method of establishing new reflexes has been used by him for investigating the higher functions of the cortex, the conditioned salivary reflex being employed as the unit sign of cerebral activity, just as the movements of flexion or extension of a limb have been used as a test for spinal function. Instead of studying the physiology of the eye, the ear, and other superficial organs, in its purely subjective aspect, we can use any of these sense organs for the establishment of a conditioned reflex or reflexes. We can proceed, untrammelled by psychological preconceptions, to study the behaviour of animals in its highest aspect by purely objective methods.

A preliminary account of his researches was given by Prof. Pavlov in the Huxley Lecture which he delivered at Charing Cross Hospital on October 1, 1906. Since that time a very large number of researches carried out by this method have been published by Pavlov and his pupils, but almost entirely in Russian, so that they are very little known, except in broadest outline, in Great Britain and other countries. It is satisfactory to learn that he is now engaged in writing a collected account of these researches which, when translated, will make them available for the instruction of physiologists, as well as psychologists, throughout the world, and will enable us to attack by this new method and with a greater hope of success the function of the cerebral hemispheres, which is indeed the capital question in the physiology of man.

Pavlov was elected a foreign member of the Royal Society in 1907 and was awarded the Copley Medal in 1915.

E. H. STARLING.

Science and the Community.

IN an address delivered in connexion with the recent celebration of the centenary of the Franklin Institute, Philadelphia, and published in the Journal of the Institute for November, Dr. A. D. Little directs attention to the curious anomaly that although all the distinctive features of modern civilisation are due to discoveries made by scientific men, yet in no country in the world is the governing and directing power in their hands. It is an interesting but very familiar fact. Dr. Little, in his own engaging and energetic style, is only saying over again something that has been said by various eminent men of science for very many years. It is a fact that not more than 100,000 men throughout the world are creatively engaged in the advancement of science, and yet a list of those features of our modern civilisation which distinguish it from the middle ages would show that they are dependent upon these men and could not continue without them. Nevertheless, the opinions of scientific workers are not asked on the direction of the civilisation that their kind have built up, nor are their services considered worthy of any special reward.

At first sight this state of affairs appears to be fantastic. Dr. Little vividly illustrates the astonishing disparity between service and award in a modern community:

"It is incomparably more profitable to draw The Gumps for a comic supplement than to write 'The Origin of Species.' There is more money in chewing gum than in relativity. Lobsters and limousines are acquired far more rapidly by the skilful thrower of custard pies in a moving-picture studio than by the no less skilful demonstrator of the projection of electrons. The gate receipts of an international prize fight would support a university faculty for a year."

All this is, of course, quite true, but the implications are a little doubtful. Is it suggested that Einstein should be paid more than the custard-pie expert, or that the expert's income should be reduced below the level of that of a professor of physics? The custard-pie expert is paid directly by the public; for the amusement he gives them they pay him an immense income. But the professor of physics does not amuse them; for the most part he bores them, and they are in no position to understand that his work is of real importance to their lives and to the lives of their children.

It seems that Dr. Little is really finding fault with the cultural level of modern communities. We may look forward to a Utopia where the proletariat would rather attend a lecture on the tensor calculus than see a comedy by Charlie Chaplin, but we must admit that that time is not yet. A more pertinent comparison would be between the salaries of scientific men and of other public servants, since the value of the work in these cases is not directly assessed by the public.

The implicit claim in the passage we have quoted, that scientific men should be rewarded with gigantic salaries, is probably not intended by Dr. Little, although the confused feeling which gives rise to it is often apparent in discussions on this subject. The money value of work done is, with nearly every kind of work, extremely difficult to assess. Indeed, the problem is probably best defined in the case of the custard-pie expert, since, if a million people (including men of science) are willing to pay a shilling for his performance, it seems that the monetary value of that performance is one million shillings. But who could possibly have assessed the monetary value of Gilbert's experiments in magnetism, or of Euler's researches on elliptic integrals? And what is the *monetary* value of the theory of relativity which, so far, has had no direct influence whatever on the life of the community? But although we think the scientific man is wrong to envy the income of the successful cinema actor, it is true that science has now sufficiently proved its value to enable the scientific man justly to insist on rewards that shall enable him to keep in good health, prosecute his work in proper conditions, and encourage him to produce and rear children. It is established that he and his offspring are a very desirable social asset; and the real injustice and stupidity of those in power are shown in the fact that even these minimum demands are not properly met.

Dr. Little also complains that scientific men are not admitted to positions of power in the community. In spite of the fact that some of them, particularly during the War, have shown themselves possessed of great administrative abilities, scientific men are not invited to co-operate in the task of government. Yet, seeing how much the modern community is dependent upon their labours, it would seem only natural that they should be given a voice in the direction of affairs. But here again we are met by a demand that requires careful consideration. For good or ill, democracy is the prevalent form of government, and, as Dr. Little says:

"An electorate, which regards itself as free, listens to the broadcast noise of manufactured demonstrations and is blind to the obvious mechanics of synthetic bedlam. The result is too often government by gullibility, propaganda, catchwords, and slogans, instead of government by law based on facts, principles, intelligence, and good will."

These are the conditions which result in the appointment of our leaders, and we may take it that the fittest survive. It is not likely that the men who can swim successfully through this welter will have much knowledge of, or reverence for, the scientific attitude of mind. It is too much to expect that they will demonstrate to the whole world their own incompetence by handing over their business to larger and better-trained intelligences. Once more, what is required is a higher cultural level on the part of the public, a general recognition of the value of the scientific mind in all departments of public life. But here we are hampered by the fact that we have no clear evidence that the majority of scientific men would be of any particular use in the conduct of affairs. It is not wise to make claims that cannot be substantiated, and the views of scientific men, taken as a whole, on political questions seem indistinguishable from the views of an equal number of ordinary citizens. With the majority of scientific men their habit of cautious weighing of evidence, their ingenuity in reducing a problem to its essentials, their lack of prejudice in coming to results, do not noticeably extend to their political opinions. They read newspapers as uncritically as does any other kind of educated man, and far more uncritically than the most insignificant Fleet Street journalist. There is no evidence that the views of the Royal Society on international politics are worthy of any special consideration.

While, however, it is true that scientific men, as a whole, rank with the rest of the community in these questions, it may be that there are branches of science in existence which could make valuable contributions to the actual problems of government. This is obviously true of problems which involve technical processes. A general scheme of electrification, for example, should obviously be committed to men of science. Questions concerned with national defence, also, should be, and largely are, in the hands of scientific men. But Dr. Little thinks that men of science could make still more fundamental contributions. He refers us to psychology, and apparently thinks that its findings could already be profitably applied to the general problems of government. This may be true, although it seems likely that the science of psychology should be further developed before any body of legislators should be encouraged to attempt striking improvements by its aid. Undoubtedly science can already furnish much besides "practical applications," but chiefly, we suggest, in giving problems a new orientation and by suggesting new methods of attacking them.

There is another aspect of the general question, an aspect that Dr. Little has not touched upon. Granted that some scientific men possess great administrative ability and that they could play a very effective part in solving problems now left to the politicians, do we want to use our scientific men as administrators? In the United States they are already employed in that way to a greater extent than is customary in Europe; but whatever the benefit to the American community, it is not clear that science in the United States has benefited by it.

Mr. Bertrand Russell has recently given it as his opinion that, in the United States, Einstein would probably have been made the administrator of a large university and, as a consequence, would never have had the leisure necessary to develop his generalised theory of relativity. Would that have been a gain? Was it a gain that Newton should have become an industrious and conscientious Master of the Mint, seeing that he produced no more original work in science for the rest of his life? Newton's work in science certainly saved the labours of two or three generations of scientific men. It is difficult to say when the theory of relativity would have been hit upon if Einstein had devoted his time to other things.

It is not at all clear that a scientific man, as soon as he has proved himself to be of great value to science, should be immediately called upon to do something else, even though the something else should be of more immediate practical utility. Dr. Little informs us that American men of science are not in Congress. Well, they are presumably in their laboratories, which may ultimately be a better thing for the world. Nevertheless, it is desirable that so valuable a group should have a means of making the weight of its opinions effective in government.

The true issue is that the scientific contribution should be worthily employed. It should no longer be left to random and sometimes base exploitation. This means that scientific men must come into the arena, and take a greater part than they have yet taken in impressing their ideals, as well as their ideas, on the public. It would not be a bad thing if scientific men developed a "class-consciousness." If scientific ideals are to gain any hold on the community it must be by vigorous propaganda, not by annual laments at the paucity of government grants. There should be lecturing campaigns and periodicals devoted solely to this end. As it is, the writers quoted by Dr. Little are able to say, with some show of justice, that science touches only the fringe of life, that it has no bearing on the centre of life at all. In a democracy one must appeal to the people. Science has a spirit as well as a body, and it is its spirit, even more than its body, which is the potential saviour of mankind.

The Study of Crystals.

(1) *X-rays and Crystal Structure.* By Sir W. H. Bragg and Prof. W. L. Bragg. Fourth edition, revised and enlarged. Pp. xi + 322 + 8 plates. (London: G. Bell and Sons, Ltd., 1924.) 21*s*. net.

(2) *The Structure of Crystals.* By Ralph W. G. Wyckoff. (American Chemical Society Monograph Series.) Pp. 462. (New York: The Chemical Catalog Co., Inc., 1924.) 6 dollars.

(3) *Chemische Kristallographie der Flüssigkeiten: Kurze Anleitung zur Synthese und Untersuchung polymorpher und kristallin-flüssiger Substanzen.* Von Prof. Dr. D. Vörlander. Pp. 90 + 30 Tafeln. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1924.) 12 marks.

IT is only about twelve years ago since the study of the crystalline state was the most neglected of all the branches of physical chemistry, so much so that a student who was full of learning about ions and about osmotic pressure would probably be unable to define a centre of symmetry or to describe the meaning of hemihedrism, unless he happened incidentally to have been also a student of mineralogy. The marvellous changes which have taken place in recent years have been due almost exclusively to the new methods of studying crystals by means of X-rays, which were discovered by Laue in 1912, and developed without delay by the Braggs. Some fifty-seven papers on the subject were already published in the year 1913, and it was only the diversion of scientific energy to other ends during the War period that kept the output for several years below thirty papers per annum. Since then, as Dr. Wyckoff's bibliography shows, the output has increased to such an extent that on the average two new papers on the subject are now being issued every week.

(1) In the midst of all this activity it is only fitting that a fourth revised and enlarged edition of the book on "X-rays and Crystal Structure," first issued in January 1915, should appear. It is remarkable that, in spite of the great developments that have taken place, this book still retains the charming simplicity of style which enables Sir William Bragg in his lectures to persuade even the simple and the unlearned that learning is both possible and pleasant, even when the subject to be learnt is the science of crystallography. The contents of the book are, however, changed almost beyond recognition, not merely by the inclusion of new matter, but also by the introduction of new types of investigation. Foremost amongst these is the application of X-rays to the study of the structure of organic crystals, where the method only indicates directly the spacing and orientation of the *molecules*, leaving the positions of the *atoms* to be deduced from a blending of stereochemistry with crystallography. In this difficult field caution is obviously needed; but not that type of caution which leads to pessimism, or to a refusal to undertake experimental investigations on the ground that the methods available are wholly inadequate to the task. It is, however, in strict agreement with the facts of chemistry that Bragg regards the diamond as the prototype of all saturated carbon compounds of the "aliphatic" series, and "graphite" as a prototype of the bewildering "aromatic" series, where a latent unsaturation lies concealed beneath a superficial appearance of saturation, like a bankrupt hiding his financial necessities from all but his most intimate friends.

Having thus secured, by the X-ray analysis of diamond and of graphite, a direct foothold in carbon-chemistry, Sir William Bragg and his colleagues have attacked a series of problems of increasing difficulty; and if the results of their investigations have not the same adamantine certainty as in the case of the elements and their simplest compounds, they have been in the highest degree useful to chemists, stimulating them into activity of thought and investigation by means of new conceptions of "chemistry in space," and by the presentation of new problems. It is indeed refreshing to see elementary sulphur treated with the organic compounds and to realise that it has after all most of the characteristics of such compounds, and to see the familiar tetrahedral model of the carbon atom used, with a sound basis of experimental fact, to explain the arrangement of the silicon atoms in quartz. Chemists would be ungrateful if they failed to welcome such intrusions from the most helpful and sympathetic amongst their physical colleagues.

(2) Dr. Wyckoff's book, although addressed to chemists, as one of a series of monographs prepared for their edification at the request of the American Chemical Society, is much inferior in its power of appeal, since no attempt is made to present the story in an easy or simplified form. Even on the first page the reader is presented with a definition of a screw axis of symmetry, of which the familiar rotational axis is treated as a special case, in direct opposition to the humane method of teaching which consists in leading up from the known to the unknown; and already on the fifth page he finds himself entering a thick forest of point groups, beginning with "Point group 1C (C_1) [Hemihedral class]." No apology is therefore needed for the statement that the book would be hard reading for a chemist who had already studied crystallography, or for the advice that a reader who is ignorant of crystallography would do well to buy an introductory text-book on the subject, and master it before tackling

Dr. Wyckoff's monograph. The book is, in fact, suitable as a guide to a research worker taking up the study of the subject, and it will be welcomed by the more mature workers in this field on account of the complete bibliography which it contains; but it is quite unsuitable for the general reader, who would find it more profitable to allow the Braggs to explain to him the methods and results of the new processes of analysis.

This does not mean that the book is of no value to the chemist; but rather that he must chew hard in order to extract small scraps of nourishment from this very strong meat. Thus it is interesting to be told that in the alums "three of the oxygen atoms in the sulphate group are geometrically alike but different from the fourth, and that the water molecules fall into two groups of six each," since this agrees with the distribution that one would picture in a double sulphate of a univalent and a tervalent metal. Still more fascinating is the statement that, in the ammonia alums, the only arrangement of the four hydrogen atoms which is consistent with the crystal symmetry is a linear one with a nitrogen atom in the centre of two pairs of hydrogens. Since this is chemically improbable (not to say impossible), it is suggested that "the ammonium group functions crystallographically as well as chemically as a single entity, and that its hydrogen atoms need not therefore occupy positions which conform to the demands of the crystal symmetry. This hypothesis probably cannot be directly tested either optically or with X-rays because it is unlikely that the hydrogen nuclei are centres of electron motions" (p. 363). It is, however, noteworthy that, in Morgan and Bragg's analysis of the crystal structure of basic beryllium acetate, the univalent methyl groups are placed with their carbon-to-carbon bonds in the line of the axes of *two-fold* symmetry, in spite of the fact that the three hydrogens of the methyl group demand instead an axis of *three-fold* symmetry. It looks, therefore, as if, in the theory of crystal structure, hydrogen again occupies an unique position, and requires to be treated differently from all other elements.

Dr. Wyckoff devotes a chapter to "Incomplete Crystalline and Non-crystalline Diffraction Phenomena," in the course of which he refers to the so-called "liquid crystals." It is now clear that these queer anisotropic liquids cannot be assigned to any known or theoretically possible class of crystals; but since they also have been subjected to analysis by X-rays, it will not be entirely out of place to include in this review a brief notice of a monograph of ninety pages by Prof. Vörlander (3), whose name has been associated, during a period of nearly twenty years, with work on the chemical aspects of this fascinating subject. So long ago as 1906–7, Vörlander showed the importance of a linear structure of the molecule for the development of anisotropy in the liquid state, and proved that in derivatives of benzene the substituents must be in the *para* position in order to produce this effect, which disappears in the case of the isomeric *ortho* and *meta* compounds.

The present monograph, under the somewhat misleading title of "Chemical Crystallography of Liquids," proceeds along similar lines, the fundamental proposition that anisotropy in liquids implies a linear molecular structure being applied as a test of the molecular form of a large variety of compounds. It is shown, for example, that where a normal propyl and a normal butyl derivative of *p*-azoxycinnamic acid have a range of stability in the anisotropic state of 112° and 103° respectively, the *iso*-propyl and *iso*-amyl derivatives, with branched chains, have a range of only 35° and 42° respectively. It is, therefore, definite evidence of the zigzagging of a hydrocarbon chain that a single CH_2 group between two aromatic nuclei prevents the development of anisotropy in the liquid, whereas this phenomenon is developed strongly when there are two CH_2 groups, and appears again in a less striking degree when the number of CH_2 groups is increased to four. Since the author claims to have laid down rules which have led to the preparation of 2000 compounds of this type, he is obviously in a very good position to discuss the origin of the phenomenon. It is also desirable to direct attention to the exceptional skill which the author has shown in securing photographic reproductions (unfortunately only in black and white) of his observations. This skill was already manifest in his earliest papers in the *Zeitschrift für physikalische Chemie*, and he has certainly not lost it in the intervening years, since the monograph now under review includes a series of sixty-one beautiful photomicrographs, which would by themselves fully justify the purchase of the book.

T. M. LOWRY.

Sexuality and Hormones.

Sexualité et hormones: les caractères sexuels considérés comme phénomènes de développement et dans leurs rapports avec l'hormone sexuelle. Par Prof. Ch. Champy. Pp. 376+7 planches. (Paris: Gaston Doin, 1924.) 30 francs.

PROF. CHAMPY is one of the most versatile and rapid of biological workers. Tissue-culture; amphibian metamorphosis; the mode of action of hormones; the theory of sex; growth;—he has touched on and illuminated all these fields within the last few years. In the present volume he presents a thesis, based on various aspects of this work, which is of considerable importance. Perhaps the best way to show its importance will be to set down a series of the established facts on which it is based, letting them tell their own story, and then criticising some of the more theoretical part of Champy's interpretation.

As everybody knows, the majority of secondary sexual epigamic characters arise in development by the more rapid growth, at one period or other, of some rudiment common to both sexes. This may take place once and for all, or regress and recur seasonally. Some years ago Pézard very thoroughly analysed the influence of the testis upon the growth of the fowl's comb, and found that whereas the comb of the capon grew proportionately to the rest of the body, that of the bird possessing a testis grew disproportionately. The former type of growth he christened *isogonic*, the latter *heterogonic*. After a certain period of heterogonic growth, however, equilibrium is attained, and growth becomes again isogonic, but at a new level.

In various lower forms of life, however, heterogonic growth continues permanently. This is true, for example, for the claws of male fiddler-crabs. Thus, the large male fiddler has, not only absolutely, but also relatively, larger claws than the small one. Here, by the way, the morphologist meets with a stumbling-block. The male fiddler-crab has *no* fixed form. Its form, in respect of the proportions of its parts, is only a function of its absolute size.

Next point: in many insects, in spite of the fact that no moulting or growth occurs after the imago stage is reached, a similar phenomenon is found; the absolutely larger individuals possess relatively larger sexual characters. This is true of the ordinary male stag-beetle, and to a remarkable degree of the Hercules and Goliath beetles. Champy rightly concludes, like his predecessors, that the definitive visible effect is due to a continuous process of growth—the accumulation at a heterogonic rate of some substance responsible for the production of the particular organ.

Secondary sexual characters, however, are not the only ones to show heterogonic growth. That is also found, for example, in the limbs of frog-tadpoles; and here, further, the rate of growth is quantitatively related to the amount of thyroid hormone present.

Then, as Lameere in France, and Geoffrey Smith in England, pointed out, the phenomenon extends beyond the limits of the single species. Within a group such as the stag-beetles, the larger *species* on the whole have relatively larger sexual characters than the smaller.

Here we clearly have a mechanistic explanation of much of "orthogenetic" evolution. Granted this particular mode of development for certain organs in a given group, then these organs will tend to become relatively larger in larger species, unless counter-measures are taken. If the course of phylogenetic evolution of the group happens to have run from small to large size, then the organs in question will show an apparently determinate evolution, although the only determinism will, as a matter of fact, be that involved in the single type of developmental machinery possessed by the whole group. This appears actually to have occurred among mammals with the horns of the Titanotheres and the antlers of the Cervidæ.

Champy also points out that the details of the heterogonic organ are usually specific, varying from species to species; while, on the other hand, the type of growth is common to all members of the group. This would imply a fundamental growth mechanism, with different individual genes embroidering the resultant organ in various ways in various species. There is also the fact that highly adaptive sexual characters, such as certain copulatory organs, ovipositors, etc., do not show heterogony, but are of fixed relative size. This we take as an adaptation, in that size-variation would interfere with nicely specialised function.

Finally, the author gives the results of some interesting experiments he has made on the growth of seasonally recurrent secondary sex-characters in Amphibia in relation to their nutritive condition. In brief, he introduces us to the following conception: for organs like the glands in the male frog's thumb-pad, or the crest of male newts, there are two limiting factors involved—first, the testis-hormone; secondly, the nutritive condition of the animal. The hormone is necessary for the appearance of the organ, but is efficacious even in very small quantities (*e.g.* when produced by small regenerated nodules of testes after attempted castration); anything above a small threshold-value exerts a constant influence. The actual effect produced when excess gonad-hormone is present, however, depends on the excess of nutriment present. Very fat frogs with a bare minimum of testes retain thumb-glands of maximal size, while unoperated but emaciated frogs show great reduction of the glands, which are sometimes not to be distinguished from those of full castrates. In practice, therefore, nutritive condition is the effective limiting factor. These considerations, as Champy justly points out, vitiate many of the castration experiments that have been carried out on amphibians.

As regards general considerations, it remains to mention two points not touched on by Champy. One concerns the quantitative side of heterogonic growth. Champy gives here some suggestive figures, but far too few to establish any assured law of growth. The reviewer has recently taken the matter up in fiddler-crabs, and finds that, if y=weight of the male's large chela, w = total weight of the crab, then $\log y = \log b + k \log (w - y)$, where $k > 1$.[1] This gives us a first firm step into the details of the process.

In the second place, there is the whole problem of what we may call *minus-heterogony*. In the cases which have so far been considered, we have *plus-heterogony*—organs grow faster than the body as a whole. But if the growth-rate of an organ were slower than that of the rest of the body, it would become relatively smaller as the animal becomes bigger. Very little attention has been paid to this problem. There seems, however, little doubt that the " degeneration " of the male elements in the female accessory reproductive system, and vice versa, will be found to be not a phenomenon of true degeneration, but of depressed relative growth-rate. It is usually not realised what an enormous difference in end-result is accomplished by a small but constant difference in relative growth-rate. In the fiddler-crabs above cited, the male chela grows about $1\frac{1}{2}$ times as fast as the rest of the body, and increases from 2 to 65 per cent. of the weight of the rest of the body during growth to a total weight of only $3\frac{1}{2}$ grams. With a growth-rate of two-thirds the rest of the body, an organ would be negligibly small in a mammal weighing 100 grams at birth. The same is probably true of very many vestigial organs, which would account for their rudiments usually being relatively much larger in the embryo than in the adult. Putting it in another way, we may say that the biologically simplest way of altering the relative size of an organ in the adult seems to be by altering its relative growth-rate during development. The study of quantitative relations during development will thus develop into one of the key-stones of biology, throwing light both upon the mode of action of genetic factors and upon the appearance of adult characters. It will stand in the same relation to morphology as does physical chemistry to ordinary inorganic chemistry.

We may conclude by a few detailed criticisms. Prof. Champy has given us that irritating thing, a book without an index. That is a vice more prevalent in France than in Britain; but custom does not make it any more excusable. He has unaccountably failed to make any reference to Geoffrey Smith, whose work, published so long ago as 1905, was one of the earliest and most penetrating contributions to the subject of heterogonic growth. He states that he has been unable to find any case of heterogony in a female secondary sex-character—a statement later qualified in the postscript, where he mentions the elytra of the females of two genera of beetles. The type of growth is, however, common in crabs, where it appears to be universal for the abdomen and abdominal appendages of the females. As regards another point, there seems no reason for abandoning Pézard's term *heterogonic* and substituting *disharmonic* for this type of growth.

The drawings are often rather sketchy, and some of the series of insects not quite so convincing as one would wish; while the section on the respective rôles of spermatogenic and interstitial tissues in producing the testicular hormone has no real connexion with the rest of the book.

However, there is no doubt that the book is extremely stimulating, and presents a large number of facts, many of them new, in a way which should excite interest and promote research in an almost untouched and very important field of biology. We have no hesitation in recommending it to the notice of systematists, morphologists, and experimenters alike.

J. S. H.

[1] See NATURE, December 20, p. 895.

The Biology of Plants.

The Biology of Flowering Plants. By Dr. Macgregor Skene. (Biological Handbooks Series.) Pp. xi + 523 + 8 plates. (London: Sidgwick and Jackson, Ltd., 1924.) 16*s*. net.

THE title of Dr. Skene's book can be interpreted in various ways and, at its widest, would embrace the entire field of botany; this could only be dealt with in the most superficial manner in the compass of a single book. Here, however, Dr. Skene has restricted himself to a consideration of the relation of the individual to its environment in the sense usually connoted by the term autecology, more particularly as regards those aspects which might be included under applied physiology. In his treatment the author has succeeded in incorporating much of the physiological work of recent years, and in a very readable manner points to its bearing on the life of the plant in Nature. The exposition is in general clear, and if the author has at times failed to steer a middle course between the Scylla of technical expression and the Charybdis of obscurity, he has at least avoided the shoals of ambiguity and misconception.

An elementary account of the soil and its function in relation to the supply of water and mineral salts is the occasion of reference to recent work on the hydrogen-ion concentration of the soil solution, the work of Weaver, Cannon, and others on root systems, and a much too brief reference to the soil organisms. The chapter on assimilation and transpiration rightly occupies a considerable section of the book. The present position of our knowledge respecting the function and regulatory action of the stomata is clearly summarised. There can, indeed, be little doubt that the *primary* function of the stomata is not the regulation of the passage of water vapour but of the gaseous exchanges involved in respiration and assimilation. This is well shown by the fact that stomatal movement is chiefly determined by changes in illumination and by the observations of Lloyd that the maximum aperture of the stomata is maintained between 8 A.M. and 1 P.M., whereas the maximum period of transpiration begins two hours later and ends an hour earlier. The high osmotic pressure attained by the guard cells in bright light probably ensures their maximum efficiency at a time when the demand for carbon dioxide is greatest, but also involves the well-known fact that the stomata may remain open whilst the rate of transpiration is excessive and the leaf actually wilts. As automatic checks to transpiration the stomata may then fail just when most needed.

The account of assimilation deals with the conditions governing the process, particularly with the results of Blackman, Willstätter and Stoll, Lundegardh, Briggs, and so on. In this connexion one may perhaps demur to the acceptance of Lundegardh's interpretation that shade leaves are less efficient in respect of diffusion than sun leaves, since the results he obtained are more probably due to the more efficient use of radiant energy by the shade leaf than the sun leaf. Comparisons on the basis of leaf area are manifestly misleading, but those in which equal weights of fresh leaf have been compared show that shade leaves are often much more efficient than sun leaves in low intensities of light and slightly so in bright light. These results, even allowing for the difference in respiration rates, are scarcely compatible with Lundegardh's assumption of slower diffusion in the shade leaf. The mechanism is possibly connected with the higher proportion of green pigments which the chlorophyll of shade leaves contains and in many cases to a higher chlorophyll content, but other factors are probably involved of which we are at present ignorant.

The succeeding chapter treats of the special modes of nutrition as exemplified in saprophytism, parasitism, and the various mycorhizal relations. This is followed by an account of the mechanical requirements of plants as shown by their gross anatomical features and morphological modifications. Reproduction and methods of dispersal, which form the subject of the next chapter, and development, which is the final section, scarcely receive adequate treatment. The work concludes with a bibliography of more than six hundred titles of papers cited in the text, and two indices which might more conveniently have been combined.

In a work covering so large a field the treatment is naturally uneven. The subject of galls, for example, is dismissed in half a page, whilst seed dispersal occupies barely ten pages of type, and the author is clearly more at home in the physiological than in the more morphological aspects of his subject. The pages are nevertheless full of interest, and it is certainly a book which students will find most helpful as indicating the trend of certain aspects of modern botanical thought.

E. J. SALISBURY.

Our Bookshelf.

The Romance of Plant Hunting. By Capt. F. Kingdon Ward. Pp. xi+275+8 plates. (London: E. Arnold and Co., 1924.) 12*s*. 6*d*. net.

CAPTAIN KINGDON WARD has written a book of considerable interest both to the lover of plants and also to the geographer and traveller, since he is able to show not only the interest which attaches to plant collecting, but also the many difficulties which the good plant collector must overcome in order to be successful. Botanists and keen gardeners are likely to be more interested in his book than the public at large since he naturally has to refer to so many plants by their Latin names. The general reader, however, is amply compensated by the fine set of pictures both of general scenes and particular plants with which the book is illustrated.

The volume is the outcome of three separate journeys in China before the War and of three undertaken during 1919, 1921–22, though the last is the one most drawn upon in the narrative. There is a good map at the end of the volume which enables the reader to follow the author in his wanderings. Those who have received seeds collected by Capt. Kingdon Ward realise that he is a really good collector as his seeds have germinated with remarkable success and he also has the keen eye for plants of interest. Whether they may happen to be "first class" in the idea of the nurseryman or not, they are certainly of value to the botanist.

Capt. Kingdon Ward tries to pretend he is not a botanist and in some ways perhaps he is not, but his early training at Cambridge, with which the writer had something to do, and his inherited tastes from his distinguished father, have given him a love for flowers and a keen interest in the remarkable play on form and structure to be met with in the vegetable kingdom. With the author's second chapter we are not wholly in accord and one would have wished that some things in it had been omitted, but this does not detract from the really interesting and, as he rightly terms it, the romantic side of plant collecting.

The chapters when the author is on the march must be read in full to be appreciated, and no review can cover the ground sufficiently to make the reading of the book unnecessary. There is much to be found in the pages beyond the mere hunting for special plants, and much of value is recorded as to the geology and geography of the regions visited. Capt. Kingdon Ward is a true naturalist and very little escapes his keen eye. The book is enlivened by interesting particulars about the various peoples with whom he came in contact;

nor is the humorous side of his travelling experiences forgotten, though no doubt at the time the humour was not always evident. We feel sure that when the good plants introduced by Capt. Kingdon Ward become better known, his name will rank high in the list of distinguished plant collectors to whom British horticulture owes so much.

Light and Sound: a Text-book for Colleges and Technical Schools. By Prof. William S. Franklin and Prof. Barry MacNutt. Pp. vi+310. (Lancaster, Pa.: Franklin and Charles; London: Constable and Co., Ltd., 1924.) 5*s.* net.

Electricity and Magnetism: a Text-book for Colleges and Technical Schools. By Prof. William S. Franklin and Prof. Barry MacNutt. Pp. xvi+294. (Lancaster, Pa.: Franklin and Charles; London: Constable and Co., Ltd., 1924.) 5*s.* net.

THE two volumes under notice are revised versions of previous editions, and are said to be suitable "for colleges and technical schools." As regards scope it is somewhat difficult to place them, for according to English standards it is curiously uneven. There are many excursions into topics of a more advanced character than is usual in books of this size (and price), but the treatment is mainly non-mathematical, and has a strong practical or engineering flavour. Nevertheless, it is usually so lucid as to repay perusal by the average "pure science" student. The sections dealing with lens imperfections and alternating current are particularly good. On the other hand, the methods given for simple lens calculations might be expected to drive even the engineering student, for whose benefit they have presumably been "simplified," to graphical methods for safety. On the whole, however, if the general viewpoint is acceptable, there will be little to criticise in matters of detail, which are usually accurate and up-to-date. An exception, albeit a trifling one, is the statement that "the most accurate wave-length measurements are made by means of the Michelson interferometer." To the English reader the frequent occurrence of such units as "abohms," "stathenries," and the like will at first be a little disquieting, but he may eventually find in their obvious convenience some compensation for their exotic appearance.

Le Volvox. Par Charles Janet. Troisième mémoire: *Ontogénèse de la blastéa volvocéenne.* Première partie. Pp. 179+planches 5-21. (Macon: Protat frères, 1923.) n.p.

IN this third memoir M. Janet approaches the problem of the ontogenesis of the Volvox blastea (cœnobium). He confines himself to the methods of cell bipartition, but in later works he proposes to discuss variations in the process and special cases. The memoir is an able attack on an exceedingly intricate and difficult problem and contains a wealth of minute detail. The author starts by pointing out the primitiveness of the Volvox cell and how, in his opinion, these blasteas are in large measure representative of the primitive animal cell groups. He then goes on to describe the apparatus by means of which he separates out the minute organisms, and having pointed out the fundamental units of the cell he considers the homologies between the blasteas of plants and animals. Thereafter he examines the divisions of the cells of *Janetosphæra aurea* (Ehrbg.) Shaw, in greater detail. It can be well understood that in such an involved study a comprehensive scheme of terms is required; these the author has supplied as well as formulæ for expressing symbolically the type of generation and the mode of reproduction of the organism under study. Assisted by 21 excellent plates containing many figures and diagrams, he traces the various divisions and shows that after bipartitions resulting in 1024 cells, the cells of *J. aurea*, having reached their minimum limits and used up all available reserves, cease to divide and enter into a new phase—the flagellate stage. Throughout, the work is one where questions regarding evolution in the plant world are always kept to the front, for the author's knowledge of plant and animal life permits him to make useful comparisons.

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend. (Griffin's Scientific Text-Books.) Vol. 2: *The Alkali-Metals and their Congeners.* By Dr. A. Jamieson Walker. Pp. xxvi+379. 20*s.* net. Vol. 7, Part 1: *Oxygen.* By Dr. J. Newton Friend and Dr. Douglas F. Twiss. Pp. xxvi+370. 18*s.* net. (London: C. Griffin and Co., Ltd., 1924.)

THE two new sections of Dr. Friend's "Inorganic Chemistry" deal with (1) hydrogen, the alkali metals, the ammonium-compounds, and the coinage-group of metals, and (2) oxygen, water, and hydrogen peroxide. The style of the book is now so well established, and so well known, that it is difficult to comment usefully on the individual sections as they appear. The parts now issued appear to be very complete in the information supplied; and the expansion of the section on oxygen to a volume of 350 pages has made it possible to include a much larger number of analytical data than it is now fashionable to quote in a text-book, as well as to deal in unusual fulness with modern work on combustion. By contrast, the volume on the metals of Group I. appears to be somewhat abbreviated, since the three metals of the coinage-group are disposed of in little more than 100 pages. Illustrations are also used less freely, being limited to a few solubility diagrams, etc., and two line-drawings, thirteen in all. The section on oxygen, on the other hand, is illustrated with some fifty diagrams, and a full-page plate showing the photographs by Burgess and Wheeler of flames near the lower limit of inflammation of methane in air. The homologues of oxygen (sulphur, selenium, and tellurium) are postponed to a later section of Vol. VII., whilst the remaining elements of Group VI. will form a separate Part III.

Venereal Disease: its Prevention, Symptoms and Treatment. By Hugh Wansey Bayly. Second edition. Pp. xvii+176. (London: J. and A. Churchill, 1924.) 7*s.* 6*d.* net.

VENEREAL disease, like all infectious maladies, is to be considered from two aspects, those of prevention and treatment. The importance of the former certainly has full recognition in Dr. Wansey Bayly's book, the preface of which is devoted mainly to a defence of the policy of the Society for the Prevention of Venereal Disease. In the first section of the book the author puts forward a scheme whereby he considers that syphilis could be almost entirely eliminated in a generation. Briefly, it consists in compulsory notification to a special Medical Officer of Health, who visits the victim, ascertains from whom the disease was contracted, and traces that individual. Infected persons are given the choice between treatment at a hospital and attendance on a physician of their own selection. Heavy penalties are attached to the doctor who fails to notify, and to the individual who conveys disease to another before being certified free from infection. Such a scheme might, however, defeat its own ends by driving the patient to abstain from treatment altogether or to obtain it secretly and illicitly at the hands of quacks.

The sections on symptoms and treatment, which comprise the greater part of the book, are clear, concise and fully up-to-date. For the student and general practitioner who have not the time to devote to large text-books, there could not be a better guide.

Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Company. Vol. 6, 1922. Pp. 238+vii. (Rochester, N.Y.: Eastman Kodak Co., 1923.) n.p.

OWING to the increasing number of communications from the Eastman Kodak Laboratory, it has been decided to issue a volume of abridgments every year. The present volume deals with the papers that were published in 1922, many of which were referred to in our columns when they first appeared. These abridgments are not mere statements of the subjects dealt with, but are the papers themselves, shortened somewhat by the omission of some of the details that are not necessary to the understanding of the work done and its results. Those specially interested will naturally consult the original publication for fuller particulars and especially for more complete data. The 30 papers included in the volume are classified under the headings of physical and photographic optics; inorganic, organic, physical, and colloid chemistry; photographic theory, and practical photography. The character of the work done is now so well known that it is not necessary to enlarge upon it, except to say that several new instruments are described that have been constructed to enable investigations to be carried further than has hitherto been possible.

The Amphibia of the Indo-Australian Archipelago. By Prof. Dr. P. N. van Kampen. Pp. xii+304. (Leyden: E. J. Brill, Ltd., 1923.) n.p.

THE Malay Archipelago, consisting as it does of a large number of islands separated in many cases from one another by very deep sea, has yielded many very interesting problems in the science of the geographical distribution of animals. Nothing perhaps could afford more useful information in the attempt to solve these problems than a thorough knowledge of that essentially terrestrial and freshwater group, the Amphibia.

Prof. van Kampen, of the University of Leyden, has therefore rendered great service by preparing for the use of students a critical study of the 254 species that are known to occur in the Dutch archipelago together with New Guinea, the Bismarck archipelago and the Solomon Islands. The descriptions of the species are mainly technical in character, but so far as possible an account of the tadpoles and some notes on habit are included. There is a useful synopsis of characters at the head of each family and genus, and there are a few excellent illustrations.

Ophthalmo-Optical Manual. By William Swaine. Pp. v+152. (London: The Hatton Press, Ltd., n.d.) 5s. net.

WE welcome the appearance of this little volume, because there is a real need for a practical handbook on the main essentials of sight-testing. In this book the subject is treated in a scientific manner seldom adopted in text-books of this nature. The more recent developments of sight-testing are considered; of particular interest are the corrections required to flat trial-case refraction values when toric and similar lenses are to be used. This was first pointed out by the author and is as yet scarcely appreciated by the average optician. The unit planes of such lenses are in quite different positions (relative to the eye) from those of the standard trial case lens, and consequently the refraction values for such lenses have to be materially altered. In addition, a number of very useful tables have been included, and these, together with an exhaustive index, make it a valuable reference book.

Warley Garden in Spring and Summer. By Ellen Willmott. Second edition. Pp. ii+41 plates. (London: Wheldon and Wesley, Ltd., 1924.) 10s. 6d. net.

THIS series of beautiful pictures of a famous garden would have been of some general interest had they been accompanied by a plan of the Warley Garden and some particulars about the plants that are in cultivation there. As it is, they are merely a collection of pictures, some of which are of no great merit. Among the best are the Alpine primroses, Plate 5, and the Nankeen lilies, Plate 31, but had the actual names of the plants depicted been given, in these and other cases, the volume would have been of far greater value to those interested in gardens.

It is to be regretted that a garden, which has so much charm and is owned by a lady who is so fitted to describe it, is merely illustrated in this series of pictures and all that is of real value is left unrecorded.

Unscientific Essays. By Prof. Frederic Wood Jones. Pp. 208. (London: E. Arnold and Co., 1924.) 6s. net.

A MAN is largely known to his friends by his hobbies, and clearly our author's hobby is to sit and reflect, occasionally feeling himself stimulated to jot down what he feels or has seen. He has a broad experience of the wild, both on sea and land, almost unexplored coral reefs of Malay and deserts of Australia. He liked the natives with whom he came into contact, and frequently he has blended folk-lore into his themes, this being perhaps the most interesting feature of his book. He tells us the crab's secret, and of course he caught a sea-serpent, his account of which we first saw repeated in the daily press with references to his official position as a professor of anatomy. As such, journalists apparently supposed him to have no lighter moments; his essays are just the thing for our ease.

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.]*

Effective Wave-lengths of γ-Rays.

ONE of the difficulties in explaining the results of experiments on γ-rays is our lack of knowledge of the variation of intensity with wave-length in the spectrum of the γ-rays. This has led to the use of "effective" wave-lengths (two, in general, being needed because scattering and absorption coefficients vary with the wave-lengths in different manners), and values have been used, which, although incorrect, apparently help to explain the experimental results. For example, I have pointed out at two scientific meetings (American Physical Society, December 1922, and the British Association, Toronto, August 1924), that if we assume, as has been done by several physicists, that the effective wave-length of the γ-rays is about 0·02 Å.U., the secondary β-rays produced in light elements by the hard γ-rays of radium-C possess far too much energy to be recoil electrons (for the properties of which see a paper by Compton and Hubbard, *Physical Review*, 4, p. 439, 1924). Experimental evidence indicates that these β-rays are not photoelectrons. If they are recoil electrons, the effective wave-length of the γ-rays must be taken as about 0·008 Å.U. in order that we may account, on the quantum theory of scattering, for their observed energy. This result, which was first obtained by a comparison of the relative penetrating powers of the secondary β-rays and the β-rays of radium-E, has led, among other things, to a consideration of the following questions.

1. What proportion of the atoms of an element emitting one or more types of monochromatic γ-rays contributes, on disintegration, to such γ-rays ?

2. Is a knowledge of the wave-lengths and relative intensities of the lines in the spectrum of γ-rays sufficient to enable us to determine effective wave-lengths and, with theoretical aid, to interpret the results of scattering and absorption experiments ?

3. Is the energy of the secondary β-rays which have been called recoil electrons greater than that given by the quantum theory of scattering ?

4. Are the γ-rays of thorium-D always more penetrating than those of radium-C, no matter what the thickness of the absorbing material used ?

I am not prepared to answer questions 3 and 4 and cannot give a complete answer to the other two. The simplest case to examine is radium-D. In the course of his fundamental experiments on the line spectra of γ-rays, Ellis (Proc. Camb. Phil. Soc. 21, p. 121, 1922) has shown that radium-D probably emits "hard" γ-rays of wave-length 0·264 Å.U., part of these rays being absorbed in producing the L and M spectra of radium-D, the "soft" rays, of average wave-length 1·06 Å.U. By a comparison of the total ionisations they produce, I find that the energy of the soft rays $=\frac{1}{2}$ that of the hard rays, and as the energy of a hard ray $=1{\cdot}06/0{\cdot}264$ or 4 times that of a soft ray (if such expressions may be used), it follows that out of every three hard rays emitted by the nuclei of radium-D atoms, two are absorbed in the atoms in which they are produced. The internal atomic absorption coefficient of the hard rays, assuming them to produce the soft rays in the way mentioned, is therefore 0·67 as compared with an external coefficient of about 3×10^{-21}. Ellis and Skinner have directed attention to the very high values of these internal absorption coefficients. It may be worth while pointing out, in connexion with experiments on the scattering of X-rays, that such a high internal coefficient of absorption is not observed with β-rays.

The energy of the unabsorbed hard γ-rays has been found by ionisation measurements to be 1/150 that of the β-rays of radium-E in equilibrium with the radium-D. Taking the average energy of such a β-ray to correspond to 467,000 volts, of a hard γ-ray to 46,700 volts, a simple calculation shows that only one in every five radium-D atoms emits a γ-ray on disintegration. Radium-D apparently does not emit "white" γ-rays or rays which give a continuous spectrum and so we have fairly complete knowledge about it, but this is not the case with most of the other elements emitting γ-rays.

In a recent paper, Ellis (Proc. Camb. Phil. Soc. 22, p. 369, 1924) publishes a table giving some of the lines in the spectrum of the hard γ-rays of radium-C, extending from 0·0453 Å.U. to 0·00557 Å.U. What appears to be the most intense line has a wave-length 0·00867 Å.U., a value not very far from that given above. Such tables, however, even if we knew the relative intensities of the lines, do not enable us to find effective wave-lengths of γ-rays, unless we are certain that only a negligible proportion of the radiation is white. That a large part of the γ-radiation of thorium-D is white, is indicated by the following evidence, to which Ellis (Roy. Soc. Proc. A, 101, p. 1, 1922) has directed attention. The lowest wave-length found by him so far in the line spectrum of these rays is about 0·014 Å.U., and yet they should have a lower average wave-length than the γ-rays of radium-C, as they are more penetrating (see question 4 above), hence the probability of white radiation of very small average wave-length. In the case of radium-C there is not sufficient evidence, so far as I am aware of it, to come to a definite conclusion about the presence or otherwise of white radiation. The following results have been arrived at.

1. If the secondary β-rays, produced in light elements by the hard γ-rays of radium-C, are recoil electrons, with energy given by the quantum theory of scattering (see question 1 above), the effective wave-length of the γ-rays must be much smaller than that usually accepted. Without going into details, I may state that one can prove from this result that no theory, as at present developed, can account for the properties of scattered γ-radiation.

2. With certain reasonable assumptions, it has been found that the internal atomic absorption coefficient of the hard γ-rays of radium-D is 0·67 as compared with an external coefficient of about 3×10^{-21}, and that on disintegrating, one out of every five atoms of radium-D emits a γ-ray.

3. The number of atoms of an element emitting one or more types of monochromatic γ-rays may be only a small fraction of the total number disintegrating and a large part of the γ-ray energy emitted may be due to white radiation.

4. A knowledge of the wave-lengths and relative intensities of the lines in the spectrum of the γ-rays is not, in itself, sufficient to enable one to determine effective wave-lengths, which can be used to interpret the results of experiments on γ-rays.

I think it may fairly be said that it is very difficult to explain the results of experiments on γ-rays of very small wave-length. Definite answers to questions 3 and 4 would help very much. There is not space here to give fully my own opinions, which I must reserve for a communication elsewhere.

J. A. GRAY.

Queen's University,
Kingston, Ont., December 6.

Specific and Latent Heats of Iron and Steel.

IN previous letters to NATURE (April 19 and September 20) I gave the results of some experiments on the rate of contraction of heated iron and steel wires, partly commercial steels, and partly of steels formed by heating nearly pure iron in graphite for periods lasting from one to five hours. It was found that even the five hours' heating in graphite did not complete, or even nearly complete, the conversion of iron into steel. A similar and more recent series of trials has now been carried out in which the graphite was replaced by wood-charcoal, from which it appears that the action of the latter is far more rapid than graphite, so much so, indeed, that a wire heated in charcoal for a single minute gives a cooling curve notably different from that of the pure iron.

Some of the results are shown in the accompanying diagram (Fig. 1), where the curves refer to nearly pure iron (4 parts in 10,000 of carbon) and to the same iron after remaining in wood-charcoal at a cherry-red heat for two and a half, five, ten, and twenty minutes, one hour, three hours, and four hours respectively. The greater part of the variation of form occurs in the first half-hour's heating, and the difference between the three-hour and four-hour curves is comparatively small.

In all cases the cooling curves well above and well below the critical temperature (*i.e.* from melting point down to about 800° C. and from 400° C. down to ordinary temperatures) are identical, but the presence of carbon prolongs the time required for the metal to change from the high to the low temperature state.

While this change is proceeding, latent heat is being evolved; and whether the wire rises in temperature and expands (showing what has been called "recalescence") during this process depends on whether the rate of evolution of heat exceeds, or falls short of, the rate at which heat is being lost by radiation and convection.

It has been shown, by experiments previously described in NATURE, that the coefficient of thermal expansion for iron and steel undergoes no discontinuous change at any temperature to which the metal was subjected. Assuming for the present purpose that the coefficient is constant, it will be seen, since the loss of temperature in cooling is proportional to the excess of temperature above the surrounding space, and since also the time taken to cool through a given number of degrees is proportional to the specific heat, that therefore the area contained between the cooling curves and the axis (*i.e.* extension in terms of time) is proportional to the total quantity of heat yielded in the cooling process.

Thus, from the results exhibited in Fig. 1, it appears that:

(1) The greater the carbon content of the metal, the longer is the time required to complete the change from the high to the low temperature state, and the lower is the temperature at which the conversion ends.

(2) The greater the carbon content, the less is the total heat necessary to raise the metal from ordinary temperature to anything above 400° C.

(3) The effective specific heat changes continuously while the change of state is in progress, but the change is more and more rapid as the carbon content diminishes, becoming probably instantaneous, or nearly so, for pure iron.

(4) The terminal specific heats (namely, from above 850° and below 400° C.) are very nearly in the ratio of one to three.

All the phenomena presented in the tempering of steel are connected with the change of state, and it seems likely that useful information might be derived from records of the contraction which occurs in cooling if made under standard conditions.

It is worth notice that in all the experiments I have made, a small permanent increase of length has

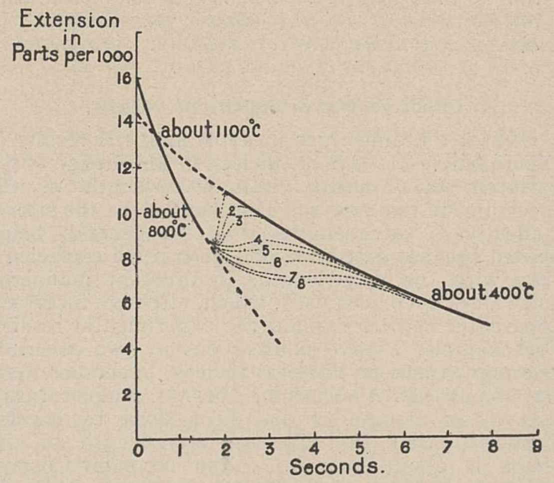


FIG. 1.—Curves showing the contraction of iron and steel wires after heating (by an electric current) in an atmosphere of nitrogen. The iron was produced by the reaction between iron sesquioxide and aluminium. Analysis showed that the metal contained about 4 parts of carbon in 10,000. A small ingot of this iron was drawn into wire of 0·02 in. diameter, and lengths of this wire were heated to a cherry red in wood-charcoal for times specified below. The ordinates of the curves give the extension of the wires at the times indicated by the abscissæ. Approximate temperatures are indicated.

Curve.	Time of heating in charcoal.
1 . . .	0 minutes.
2 . . .	2½ ,,
3 . . .	5 ,,
4 . . .	10 ,,
5 . . .	20 ,,
6 . . .	60 ,,
7 . . .	180 ,,
8 . . .	240 ,,

occurred at each successive heating when the iron was nearly pure, but that when the carbon content reaches a certain limit this change vanishes, and is replaced by a small permanent contraction when that limit is exceeded.

A. MALLOCK.

9 Baring Crescent, Exeter,
December 6.

An Endotrophic Fungus in the Coniferæ.

IN a communication to NATURE of December 13, Prof. F. J. Lewis directs attention to the discovery of intercellular mycelium in the shoot tissues of *Picea canadensis* and other conifers, and also in roots and shoots of *Ledum palustre* and *Vaccinium Vitis-idæi*. Referring to the two last-named species, Prof. Lewis writes: "an examination of the root and stem of *Ledum palustre* and *Vaccinium Vitis-idæa* from this district has been made, and an endotropic [?endotrophic] fungus has been found similar to that described by Rayner (*Annals of Botany*, 1915) in European material."

The fact that endotrophic mycorrhiza occurs in the *roots* of these plants has long been known and calls for no comment. A full account of the mycorrhiza of *V. corymbosum* was given by Coville in 1911 for American material.

In the paper cited by Prof. Lewis, the present writer described the wide distribution of mycelium throughout the shoot tissues of Calluna and recorded the fact of ovarial infection—implying a like distribution of the fungus—in *Ledum palustre* and *Vaccinium*

Vitis-idæi. A paper now in the press, recording the regular and extensive digestion of mycelium in the mycorrhiza cells of Calluna, contributes additional details respecting the distribution of mycelium in the shoot of Ling and supplies final experimental proof of the identity of the fungus (in the vegetative shoots as in the fruits) with that found in the (root) mycorrhiza.

In view of the conclusions published by Stahl in 1900, the genus Vaccinium is of special interest. In a paper shortly to be published, an account will be given of experimental researches on Vaccinium spp. extending over a number of years and evidence supplied that the relation between fungus and vascular plant is even more intimate in this genus than in Calluna. That roots of Vaccinium are infected by mycelium of the endophyte when growing in sterilised soil was overlooked by Stahl,—as more recently by Christoph in the case of Calluna,—because the formation of typical mycorrhiza is partially inhibited in the roots of both these species when growing in a sterilised medium. Under these conditions, the demonstration of mycelium in the mycorrhiza cells demands a more careful technique than was bestowed upon it by either of these observers.

The interesting observations on conifers contributed by Prof. Lewis confirm the view long held by the present writer, that the distinction between ectotrophic and endotrophic mycorrhizas is one of degree of infection only. Many of the so-called ectotrophic forms yield evidence of the presence of intercellular mycelium when a suitable technique is employed. This view receives further confirmation from the recent extensive researches of Melin (" Experimentelle Untersuchungen über die Konstitution und Ökologie der Mykorrhizen von *Pinus silvestris* L. und *Picea Abies* (L.) Karst," *Sonderabd. aus myk. Untersuch. und Berichte*, Bd. II., 1923, Stockholm).

At the same time, it must be pointed out that the presence of mycelium throughout the shoot tissues does not in itself constitute a proof of identity with the mycorrhizal fungus of the same plant. Experimental proof of such identity has been obtained for Calluna and Vaccinium, but it is perhaps rash to assume, by analogy, that the same is true for *Picea canadensis* and other conifers.

Prof. Lewis's allusion to " symbiosis " raises the question of the exact significance to be attached to this term. In my opinion the term " symbiosis " can be correctly applied to the relationship between flowering plant and fungus in mycorrhiza plants if it is used as originally defined by de Bary. Its use when *mutualism* is implied is justified only if supported by experimental evidence. Each case requires investigation on its merits.

M. C. RAYNER.

The Nature of Verse.

THE experimental results reported by Prof. Scripture in NATURE of October 11, p. 534, are of course to be accepted as accurate, but they do not lead inevitably to his conclusions. He is dealing only with " the physical nature of verse," with verse " as it comes from the speaker " and passes to the hearer. Of this he gives a faithful and valuable account; but it is wrong to draw conclusions as to the nature of verse from an inquiry into only one aspect of it.

To express the rhythmical effect of verse Prof. Scripture uses a concept—that of the centroid—which deserves fuller recognition. He states that " The simplest English poetical line consists of a quantity of speech-sound distributed so as to produce an effect equivalent to that of a certain number of points of emphasis at definite intervals." Few will take exception to this, so far as it goes; but he draws the conclusion that verse is " purely a matter of rhythm; it has no metre. The usual scheme of prosody with feet, syllables, iambus, trochee, etc., is a fantastic fabric of fancy without the faintest foundation in fact."

A certain amount of poetical work makes no claim to be metrical, but apart from this it is untrue, even on Prof. Scripture's evidence, that verse " has no metre." If the centroids recur at definite intervals then they may be said to mark out measures, bars, or feet, the " point of emphasis " marking either the beginning or the end of the foot. There is no need for the feet to be conterminous with syllables, or to be cut off one from another as if the speech sound were not continuous, or to show any simple or indeed any fixed internal ratio between their parts. Prof. Scripture may object that this is not the *usual* scheme of prosody, with feet, syllables, etc., that he is attacking. But we may believe in metre without supporting the orthodox prosody of mid-Victorian days. That scarcely needs slaying thrice, although modern metricians who no longer accept it find the old schemes and terminology convenient to use for rough and ready purposes.

A more important point is that Prof. Scripture takes no account of the fact that the physical rhythm is the external manifestation of a psychological rhythm. One of his examples illustrates this. Whoever read the line from " Hamlet " for him to record evidently felt " is " to be more important than " that," and the record accordingly shows the arrangement of centroids to be

To be or not to be: that is the question.

But many, if not most, readers would place the point of emphasis on " that "—

To be or not to be: that is the question:

the record showing a different arrangement of centroids.

The nature of the sound rhythm depends on the nature of the mental rhythm with which it corresponds (or perhaps we may find that they are mutually dependent). Consequently, experimental methods, however accurately carried out, can by themselves reach no finality. " The first step in the study of verse," says Prof. Scripture, " must be the purely physical one of registering and analysing the air-vibrations." But even if this is so, it is not all. We have also to inquire why the vibrations come to be arranged in that particular way. The problem of metre is not a merely phonetic problem, for the effect of verse depends not merely on some stimulation of the senses, but on something that is a matter for apprehension on a higher or more complex level than mere sensation, on the *recognition* of some sort of recurrence.

EGERTON SMITH.

Krishnagar College, Bengal.
November 17.

The Origin of the Satellites of Mercury Lines.

INTEREST in the complex structure of the important lines in the arc spectrum of mercury has been revived by the suggestion of Nagaoka, Sugiura, and Mishima (NATURE, March 29, 1924) that the satellites are due to isotopes of mercury. The suggestion is based on the agreement of the wave-lengths calculated according to a hypothetical formula (similar to Kratzer's formula for the spectrum of hydrogen chloride) with the measured wave-lengths. On the other hand, Ruark, Mohler, and Chenault attribute the fine structure of the lines to "transitions between components of complex spectral levels" (NATURE, Oct. 18, 1924). They are satisfied that in the great majority of cases it can be proved that fine structures are not due to isotopy.

There are two conditions which must be satisfied by lines arising from isotopes: (1) the intensities of the several isotope lines in the radiation from a thin layer must be in the ratio of the concentrations of the respective isotopes; (2) the radiation from the end of a long column should be distinguished by the equalisation of the brightness of corresponding lines when the column is sufficiently long for the lines to be "saturated." We have directed attention to this point in a recent paper (Proc. Roy. Soc. 105, p. 527, 1924).

The application of the first test is difficult, but the second is possible in some cases. In the case of 5461 Å all the satellites approximately satisfy the second condition, with the exception of one, namely, —·024 Å. In the long column radiation the satellite —·024 Å is the brightest line of the group, and all the others are so nearly of equal brightness among themselves that the distinction, based on difference of intensity, between "main line" and "satellite" is lost. It appears to us that if the components of this group are to be attributed to the isotopes of mercury, the line —·024 Å must be excluded from the list. It appears, however, from the note of Nagaoka and his co-workers that they include this line in the isotopic group of 11 satellites, which, together with the main line, make up the whole group of 12 constituting 5461 Å.

In the case of the two yellow lines 5791 Å and 5769 Å, these authors state that the observed wave-lengths of the satellites of 5791 Å agree with the calculated wave-lengths, whereas there is no agreement in the case of 5769 Å. We, however, find that the side components of 5769 Å can be reversed on a continuous background, and that in long column radiation they approach the main line in brightness, whereas in the case of 5790 Å, we have been able to reverse the main line only, and the ratio of emission to absorption is greater for the satellites than for the main line. Thus the components of 5769 Å appear to satisfy the second condition we have mentioned above, while those of 5971 Å do not.

E. P. METCALFE.
B. VENKATESACHAR.

Central College, Bangalore,
University of Mysore,
November 27.

Chemical Combination of Helium.

THE views of Franck on the existence of a metastable form of helium capable of forming chemical compounds have led me, at the suggestion of Sir Ernest Rutherford, to search for such compounds. The experiments carried out during the past year indicate the existence of helium compounds of a different type from the mercury helide described by J. J. Manley in NATURE of December 13, p. 861.

I have examined mixtures of helium with the vapours of mercury, iodine, sulphur, and phosphorus under the influence of electron bombardment and in the presence of surfaces cooled by liquid air. I find the helium disappears almost completely at a rate much greater than that observed under the ordinary conditions in a discharge tube. Solid substances, which I believe to be compounds of helium, were condensed on the cold surface together with an excess of the other element used.

Numerous experiments were carried out which showed that the effect was not due to mechanical occlusion or adsorption. In the absence of a cold surface, a slow and very slight disappearance occurred, and the helium could only be recovered by heating the apparatus to 300° C. Experiments showed that this absorption or mechanical occlusion of helium in condensed vapours was very slight.

The substances obtained have a vapour pressure of the order of 0·005 mm. of mercury at −185° C. On allowing them to warm up, they decompose very suddenly at definite temperatures, and the original amount of helium is recovered. In the cases of mercury and iodine, this temperature is approximately −70° C. and for sulphur and phosphorus −125° C. The only disappearance of helium above these temperatures was of the order to be expected from the experiments described in the preceding paragraph. In appearance, the compounds of mercury and iodine are not like the pure elements, but at the temperature of decomposition the appearance changes to that of ordinary deposits. In the case of phosphorus, when the reaction is allowed to proceed, the deposit is yellow, but, if no reaction occurs, red phosphorus is obtained as might be expected since the vapour passes over a hot filament.

Preliminary determinations of the velocity of reaction have been carried out, and further work on this point is in progress, as well as experiments which it is hoped will determine the composition of the products.

E. H. BOOMER.

Cavendish Laboratory,
Cambridge,
December 16.

Double Rainbows.

WHEN the source of light is at a practically infinite distance, as in the case of the sun, the position of the bow is determined only by the positions of the source and of the observer's eye. When, therefore, a bow is seen double, there must be two effective sources. The phenomenon described by Mr. Deodhar in NATURE of December 13, p. 860, cannot be explained as due to two parallel rain showers. Moreover, his laboratory experiment with a source of light near to the observer would be likely to mislead him, for the conditions brought about by the near approach of the source are greatly and strangely modified (see NATURE, Vol. 105, May 27, 1920, p. 389).

Two bows of the same radius but about two centres, one above the other, have been observed by the writer, the lower cast by the sun and the upper by the image of the sun reflected in a surface of water. In the case described by Mr. Deodhar the sun was low and rising, and if the upper bow were due to a reflected image the two bows would gradually separate and not approach one another as he observed them to do.

Mr. Deodhar does not state in his letter whether he looked round to observe the sun at the moment. Perhaps he would have seen a second source of light, such as a small patch of brilliantly illuminated cloud near to and approaching the sun. Another explanation that may be suggested is the duplicating of the sun's image by mirage or some other form of abnormal atmospheric refraction. The low altitude of the sun would favour this latter explanation.

C. O. BARTRUM.

32 Willoughby Road, Hampstead,
December 15.

Historical Aspects of Malaria.[1]

By Dr. ANDREW BALFOUR, C.B., C.M.G.

MALARIA AS A DESTROYER.

DESPITE all the knowledge gained by able and devoted men, despite the application of that knowledge in certain places, despite heavy expenditure, malaria remains one of the great killing and crippling diseases of the world. Let us consider some of the ancient records and see what they have to tell us. First of all, however, it seems fitting, in the centenary year of Byron's death, to recall the last lines from his "Destruction of Sennacherib"—

> And the might of the Gentile, unsmote by the sword,
> Hath melted like snow in the glance of the Lord.

It is of interest to note that Genovese, an Italian author who recently wrote an informative paper on "La malaria castrense"—that is to say, malaria in camps and incidentally in armies—is inclined to attribute the destruction of the Assyrian host to malaria. It is of course impossible to be certain, but Palestine, then as now, was an intensely malarious country, and it is conceivable that a severe outbreak of malaria decimated the Assyrian army. If so the poet unwittingly approached the truth when he wrote:

> For the Angel of Death spread his wings on the blast—

though, as only the female mosquito attacks man, *her* wings would have been nearer the mark. The rapidity with which the destruction was accomplished as recorded in the Book of Kings is against malaria, but we need not take too *literally* the single night in which it is said that a hundred fourscore and five thousand perished.

Although it is impossible to speak with certainty, there is little doubt that ancient Egypt was heavily plagued by malaria. We know that it was a country full of great marshes, the remains of some of which persist to the present day, and the following passage from Deuteronomy has been cited as evidence of the existence of paludism: "The Lord shall smite thee with a consumption and with a fever and with an inflammation and *with an extreme burning* and with the sword and with blasting and with mildew; and they shall pursue thee until thou perish."

It is not, however, until we turn to ancient Greece that we obtain anything like a true picture of malaria and its ravages. In "Malaria and Greek History," which Mr. W. H. S. Jones, of Cambridge, inspired by Sir Ronald Ross, wrote and published in 1909, it is claimed that malaria was the cause of Grecian decadence. Mr. Jones speaks of the malaria blight which fell upon many fertile districts of Greece about the fifth century B.C. He quotes the Wasps of Aristophanes to show that malaria, the "nightmare" disease as it was called, had invaded Attica, and that fevers and agues throttled the sires and grandsires of the Athenian people. He cites the treatise of Hippocrates on Airs, Waters and Places as proof that the father of medicine was very familiar with the dire results of malaria cachexia, with that chronic malaria which even to-day is wellnigh as hard to cure as it is to endure. Those who drink the water of marshes, said Hippocrates, have large spleens, but thin faces and shoulders. Again, after referring to the lowering of the birth-rate, owing to the physical condition of the women and the shortening of the span of life, he describes in a famous passage the people who dwell in low meadowy and hot districts, where the winds and waters are warm, as neither tall nor well-built, but short, fleshy, dark-haired, dark-coloured and bilious. They are neither courageous, nor of great powers of endurance. The stoutness to which reference is made is doubtless perplexing, for the malarial cachectic is usually emaciated, but it may imply that the sufferers were œdematous or in an unwholesome condition. There can be no doubt that in 400 B.C. large tracts of Greece were in a miserable state owing to malaria, while 200 years later the assertions of Polybius as regards the rapid depopulation of the country owing partly to emigration, partly to a heavy mortality, point, in some measure, to its malign influence.

In the olden days marshes surrounded Athens. The Stadium was a swamp, and armies fighting round the capital suffered enormous losses. It is recorded by Polyænus that Clearchus the tyrant, with the view of getting rid of a number of riotous and disaffected citizens, conscripted them to invest a town "in the dog days"—that is to say, in the summer—and made them encamp in a marshy plain "ill-ventilated and full of marshy pools," while he and his mercenaries occupied the surrounding hills. The effect was rapid and terrible, for the wretched men were wiped out by malaria. It is true that Dr. Cardamatis, of Athens, a well-known malariologist, does not agree with the conclusion reached by Mr. Jones, for he thinks the English author has overlooked the remarkable reclamation works carried out by the ancient Greeks, notably by the Minyans on Lake Kopais. He attributes the decay of the nation to other causes than malaria, but, be that as it may, the destructive agency of the mosquito-borne disease is well exemplified in ancient Greece, where towns were actually given names signifying "heavy sickness." Some of these names, such as Kounoupia, Konopina, and Kounopitsa, exist to-day.

There are some who would attribute the decline and fall of Rome to the evil influence of malaria, and certainly in olden days the environs of the imperial city were described by classic authors, such as Cicero and Livy, as "Pestilentia." Tacitus states that Gallic and Germanic troops suffered severely by camping in the insalubrious neighbourhood of the Vatican, where the lands were covered with stagnant water and the air was unwholesome. Even at the present day a suburb of Rome is called "The Vale of Hell," and three-quarters of its inhabitants are saturated with malaria.

Genovese, already quoted, refers again and again to the havoc wrought by malaria amongst armed hosts. Many large Carthaginian armies faded "like mists before the wind" because of it, and the losses amongst the Roman armies in the wars against Hannibal must have been incalculable.

It is Banister the American, however, who brings things nearer home, for he declares that Brennus would undoubtedly have taken the Capitol at Rome had he

[1] From a discourse delivered at the Royal Institution on Friday, May 23.

not, in A.D. 208, lost in "Caledonia stern and wild" 50,000 out of 80,000 men from malaria.

So much for Europe long ago. A single example may be culled from the tropics, from the fate which overtook the people who built the lost cities of Ceylon, those wonderful ruins in its north central areas. Lucius Nicholl, of Colombo, believes, with some reason, that their ruin was occasioned by malaria. He points out that the ancient cities really owed their existence to the field labourers, who, by constructing tanks and by rice cultivation, made the country prosperous and self-supporting. It is reasonable to assume that the stress of devitalising diseases would fall upon them, and as the climate and the rainfall have not altered, there is every probability that malaria was imported from India with dire results.

However interesting and suggestive these records and experiences from ancient times may be, they scarcely appeal so forcibly as those from later periods. Take the extermination in the Roman Campagna in 1167 of the finest army ever commanded by Frederick Barbarossa. So rapid and awful was the destruction that the writers of the time have represented the disease as a "black cloud which covered all the valley near the Monte Mario, where the army was situated, and poisoned the air." A heavy rain had fallen in August and converted the place into a boundless swamp; then followed an enervating spell of hot weather, and an irresistible invasion of the wretched troops by fever. "Obscure soldiers, nobles and illustrious prelates laid down their lives there," says Genovese. The flower of a nation was exterminated, while in the same outbreak Rome lost some 20,000 inhabitants. Throughout the Middle Ages there were many deadly epidemics of the disease, like that of 1557–58 in England.

Let us fare to the tropics once again, and see how malaria wrecked high hopes and a well-found expedition when the ill-fated Scottish Darien scheme came to nought. The settlers landed on a pestiferous spot of land in 1698 and speedily came to grief, mainly, if not wholly, by reason of disease. There can be little doubt that malaria was the chief malady which overcame them, though yellow fever may possibly have been operative. At any rate, the "Memoirs" of the Rev. Francis Borland, who was one of the chaplains to the second portion of the expedition, leave one in no doubt that mosquito-borne fevers wrecked the enterprise. Two hundred years later a similar want of skill, due chiefly to lack of knowledge, occasioned, not far from Darien, a similar melancholy tragedy when the French failed in their great endeavour at Panama. It must be remembered that, though yellow fever proved their main adversary, malaria wrought much havoc in their ranks. It was left to the Americans, the heirs to learning gained partly by others, partly by themselves, to triumph over malign local conditions.

I have spoken of camps and armies, but navies have also felt the weight of malaria; the British Navy has suffered from it time and again. Perhaps the most dolorous account of its ravages is to be found in the records of the forgotten Batavian endemic, as it was called, which occurred in June 1800, when we were fighting the Dutch in Java. The ships concerned were the *Centurion* and the *Daedalus*—historic names. Seamen, marines, and soldiers alike suffered. The place of tragedy was the small island of Edam, nine miles offshore from the low swampy grounds of Batavia, and the remarks of Shields, the naval surgeon who is the chronicler of the disaster, are highly suggestive. He speaks first of Onrust, a small island only three miles from the main, well cleared of trees, underwood and jungle, nearly flat and free from swamps and marshes. Speaking of the sick brought here from the ships blockading Batavia, he says:

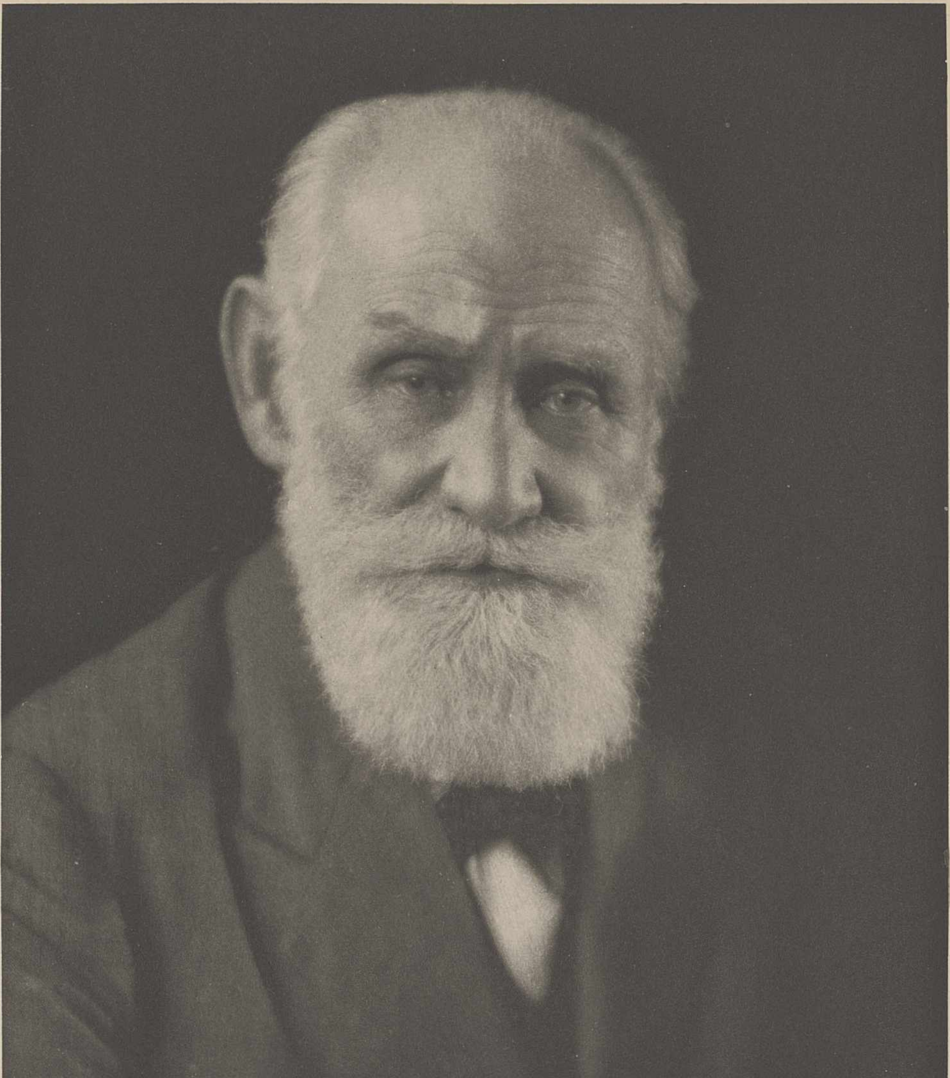
"From the fœtid exhalations, which were conveyed by the land winds from the neighbourhood of Batavia, the sick were easily secured, by closing certain apertures in their apartments, till the sun dispersed the vapours in the morning; after which there did not appear to be any danger from the miasmata disengaged during the day. Edam, on the other hand, though farther out of the reach of Batavian exhalations, is covered with trees, long grass and jungle, having a part of the island itself in a stagnant, marshy state. The buildings here were indifferent, and only one long ward could be found for the sick and convalescents; in consequence of which the latter class of patients experienced all those dire effects produced by the depressing passions, forever nurtured by the melancholy scenes of death, which this fatal spot too constantly presented to their view! Thus, in running from a doubtful danger, they precipitated themselves on certain destruction. In leaving Onrust (a cleared space) to avoid the effluvium of Batavia, weakened and diluted by a three miles passage from its source, they settled on the jungly and marshy island of Edam, where pestilent miasmata, in a concentrated form, issued from every foot of ground around them! The fatal effects which followed were predicted by an intelligent surgeon on the spot, but his suggestions were disregarded or overruled; *distance* from the main being held paramount to all other considerations."

I might trace the deadliness of malaria from the Walcheren expedition, which it ruined, to the Crimea, where it played havoc, and on to Macedonia where it, more than any other single factor, rendered the Allied Forces in the War comparatively impotent. I might tell you of great epidemics in India, of its strangling hold on the West Coast of Africa, of how the Indians in Mexico suffer and die from it; of the appalling conditions at present existing in Southern Russia; but I prefer to take one great classical example of its powers for evil within recent times—its invasion of Mauritius. It is unnecessary to consider the rights or wrongs of the story generally believed—to wit, that in the late 'sixties of last century, African malaria-carrying mosquitoes were introduced from a sailing ship, multiplied exceedingly, found infected blood already present in the bodies of Indians from India or Creoles from Africa, and commenced spreading the parasite, and incidentally the disease. I would rather give one or two passages from a book on Mauritius by Nicholas Pike, who was American Consul at Port Louis in 1867–1868, and was an eye-witness of the scenes.

"Those who inhabited Port Louis," he says, "during the terrible mortality in 1867 and 1868 will never forget the sad spectacles the city presented daily. Fever! Fever! was the only word on every lip—the only thought in every heart. Mourning and desolation everywhere. Scarcely a person visible that did not wear the garb of woe. Song and laughter had ceased.

"Port Louis was once remarkable for the number

Supplement to "Nature," Jan. 3rd. 1925



Lafayette photographer

Emery Walker ph.sc

I. P. Pavlov

of pianos heard in every street in an evening, from the Erard's grand and semi-grand to the humblest cottage instrument.

"At this time it was literally 'The daughters of music were brought low and the voice of mourning was heard in the streets.' Funeral trains were met at every corner. Relays of men were kept busy night and day digging the graves."

I have seen these graves, mute witnesses to the severity of the outbreak, to the dire results of ignorance. For months an average of 200 people died per day in Port Louis, and scenes such as Pike describes were common.

Think of what all this means, and what the discovery of the malaria parasite, and of the method of infection by the mosquito, has meant, and how much more it would mean if only men and governments would act energetically and enthusiastically upon the knowledge gained. When Mauritius passed through its furnace of affliction, and 31,920 persons perished, Laveran was a student at Strasbourg and Ross a schoolboy at Ryde.

We have dealt with malaria as a destroyer *en masse*, but before looking at the reverse side of the medal and noting how it has benefited mankind, let us see what it has done in the way of removing notable persons in the historical sense, some of whom at least were valuable assets either to the communities they served or to the world at large. Naturally enough it is difficult to obtain trustworthy records from the far past. In those days the word fever covered, if not a multitude of sins, a great variety of febrile disorders, and it is only in a few cases that definite clinical evidence is forthcoming which enables us to say that so-and-so undoubtedly perished from malaria. Even in comparatively recent times accurate diagnosis was difficult, for malaria is a very protean disease, and cannot be definitely predicated without the use of the microscope. Hence my examples are scanty and some are doubtful.

Alexander the Great conquered the world, but there is some reason to believe that malaria conquered him, aided by his excesses and his disregard of precautions. Vasco da Gama voyaged half round the globe, but he voyaged to another, and it is to be hoped a better, land at the bidding of the malarial plasmodium—at least so it has been said. Anyhow he died of fever at Cochin, and his fatal illness was probably malarial in origin. "The wisest fool in Christendom" was undoubtedly killed by malaria. He died of ague at Theobalds. One of his predecessor's stoutest, but not too reputable servants, the bold Sir John Hawkins, had his end hastened by, if indeed it was not actually due to, the same disorder. Oliver Cromwell also, who died of ague at Whitehall, yielded his life to the insidious attack of the malarial parasite. Whether Byron was a victim of the disease when he died in his beloved Greece is a moot point. Sir Ronald Ross is inclined to think malaria was not guilty in this instance.

Careful research might add other names to this brief list. One would expect that of the great explorers in the tropics some were wiped out by malaria, but I have not been able to find indubitable evidence in the case of the greatest of them.

MALARIA AS A BENEFACTOR.

Until very recently it would not have been possible to adduce evidence showing any *direct* benefit to man from the disease malaria, but a surprising development took place a few years ago when Prof. Wagner-Jauregg, of Vienna, began to treat cases of general paralysis of the insane—the dreaded G.P.I.—by introducing into the blood of patients the organism causing malaria, thereby producing in these patients attacks of malarial fever. He had noticed, as had others, the beneficial effects of febrile attacks in cases of general paralysis, and conceived the idea of inducing high temperature repeated at short intervals. It occurred to him that this is what the malaria parasite accomplishes in its victims, and that it might be used as a curative agent. Although patients were treated on these lines so early as 1917, nothing was published on the subject until 1920; but the remarkable results obtained in certain instances, and the fact that, in most cases, distinct benefit resulted, led to extensive trials of the new treatment on the Continent, and later to its employment in Great Britain.

Ere now one malady has been used to combat another, but never before has a serious disease been utilised in therapeutics which, once its good work is accomplished, can be effectively and speedily controlled. This is possible in the case of malaria, thanks to quinine, which, so far as its introduction into Europe is concerned, we owe to a woman, the Countess of Chinchon. We are able also to select one of the three forms of malaria which is the least dangerous, but naturally care must be taken that this use of the malaria parasite as a drug does not result in its dissemination by mosquitoes from those treated by it. In Great Britain there is little danger of such an accident, but in Germany serious attention has been directed to it.

The method, promising though it be, is still in its infancy. It is possible that it may be applicable to other diseases of the central nervous system, at least those due like G.P.I. to a specific spirochæte; but great care must be exercised, and this new therapy should be in the hands of experts familiar with the malarial plasmodium, and able also to gauge its effects. Those effects, it may be said, are not exercised on the other parasite, the spirochæte, nor does the high temperature affect this invader. The action appears to be on the damaged tissues of the brain itself; but the precise mechanism is still obscure. If, however, malaria proves itself able to cope with locomotor ataxia, with disseminated sclerosis, and with paralysis agitans, then indeed it will be hailed as a benefactor, and be considered as having in some small degree made amends for its past atrocities.

Indirectly malaria has undoubtedly aided the human race. Mr. Jones ingeniously argues that it was responsible for the increased respect shown for women in the later days of ancient Greece, and cites the New Comedy (320–250 B.C.) as proof thereof. He considers that the value of women as nurses was made apparent by it, and that, as the wife was usually the nurse, endemic malaria vastly increased her duties and importance.

The chief indirect beneficial action of malaria is to be found, however, in the way it has stimulated men to thought and action. From the earliest days mankind was forced to exercise ingenuity in protecting themselves from fever. Egyptian and Cretan fishermen slept under fishing-nets folded again and again until their meshes were small. They believed they were excluding miasmata, but they were really keeping mosquitoes at bay. Yet so little is history regarded, perhaps because Herodotus wrote of this habit of Egyptian fishermen as a mere curiosity, that we find Prof. Traill in 1837 stating that the proposal to defend the body against marsh miasma by the interposition of gauze nets was first made by Rigaud de l'Isle in 1817, and recording that Brocchi had taken up the same idea, and averred that he had successfully employed it against malaria.

Malaria inclined men from very early days to attribute the infection of fevers to mosquitoes or other biting insects. Susruta, an Indian physician who probably flourished in the fifth century B.C., taught this truth, and there is a picture of him expounding it to an Eastern potentate.

Varro and Columella at the time of the Christian era associated mosquitoes with insects bred in marshes; but perhaps the most remarkable announcement was that of Lancisi, who, in 1717, stated that marshes were the cause of the fever owing to the transformation of minute worms into "stridulous culices," and that the poisoned animals kill, not by the wounds which they inflict, but by infusing a poisoned liquid through the wounds. The Abbé de Fortis, writing of his "Voyage in Dalmatia" in 1774, refers to his meeting with an ecclesiastic who suspected that fevers were due to insects, the infection being derived from corpses or poisonous plants, and who thought that miasmas might be conveyed in this manner. The conjecture, says the Abbé, is at least ingenious.

So it went on with such protagonists as Nott the American, Beauperthuy the famous French Creole, Finlay of Havana, and King, the soundest of them all, reasoning and arguing in favour of the hypothesis and none paying much attention to them. Yet malaria had taught benighted barbarians the lesson and they had accepted it. Richard Burton in his "First Footsteps in East Africa," published in 1856, states that the people of Zayla in Somaliland believed that mosquito bites occasion deadly fevers, and says that the superstition (save the mark!) probably arose from the fact that mosquitoes and fevers became formidable about the same time.

But malaria led also to closer and more scientific reasoning. The ancestors of the malaria parasite were probably coccidia, tiny protozoa inhabiting the cells lining the wall of the intestine. Some of these, naturally enough perhaps, got a little discontented with their surroundings, changed their habit of life, and eventually found a more congenial habitat in the red blood corpuscles. Now Richard Pfeiffer, a trained observer, had been studying the coccidia of rabbits in 1889–90. He noticed that these parasites not only multiplied within their host, the rabbit, but, in a special resistant form, provided for their transference to another rabbit once they had got outside the body of their original host. He recognised that the multiplication of the coccidia in the epithelial cells of rabbits and that of the malaria parasite in the red blood cells of man was a very similar destructive process, and thought that possibly the malaria parasite, like the coccidium, might have two cycles of development. If so it would have to get outside man's body. Provided it did not produce any resistant form to enable it to withstand the dangers it would encounter in the wide, wide world, say in soil or water (and such a form was unknown), he considered that it might make use of some insect in which, sheltered and comfortable, it could undergo the second, or as it is called exogenous, cycle of its development. It could then, as Koch had suggested to him, get back to man through the bite of some blood-sucking insect.

This, as events have shown, was a prophetic utterance, but it was linked up with the earlier work of the great Sir Patrick Manson, who, long before, working in Amoy, far from books and skilled help, had proved that a mosquito served as the intermediate host of a human blood parasite, that tiny filarial worm, to the presence of which in the human body the disease elephantiasis is attributable. He showed that the mosquito was a necessary link for the fulfilment of the life-cycle of the bloodworm. This was a new conception in pathology of which both Koch and Pfeiffer were aware. Still this does not detract from the merit of Pfeiffer's carefully reasoned hypothesis. Neither he nor Koch, however, followed up the matter. The solution of the problem was left to Ross, who, at Manson's instigation, took up the work in India, and after manifold trials and tribulations emerged victorious. Certain Italian observers also contributed notably to our knowledge, and Ross himself, not content with mere scientific work, at once turned it to practical account.

Malaria, then, benefited man by stimulating him to undertake work for its own destruction, surely rather an altruistic action, and not unlike that of the medical profession itself. This stimulation has had other and far-reaching results, for, more or less as a direct outcome of the discoveries regarding malaria transmission and prevention, attention was directed to all kinds of protozoal and allied diseases. The American work on yellow fever was, in fact, the sequel to the researches of Ross, and an immense stimulus was given to the scientific study of tropical medicine and hygiene. One of the latest developments has been the application of electricity for the purpose of destroying mosquito larvæ and pupæ. Montellano, of Argentina, introduced the method of electrocution which is now being given an extensive trial.

Not only did malaria excite inquiry and interest, but education of the public was also found needful, and propaganda were launched broadcast. Man's ingenuity was stimulated afresh, for it was by no means easy to explain to lay audiences the intricate life-history of the malaria parasite; and further, his enthusiasm was aroused in an endeavour to present the problems of preventive work in an attractive and effective manner. Here it is that the Americans have forged ahead. Malaria is a very serious problem throughout the Southern United States, and indeed has been the reason why some of them have, until lately, been backward and depressed. The Americans are a practical people, and moreover are easily fired by that idealism which, if well regulated, so often spells success. Hence they have spared neither time nor money in combating malaria and bringing before the public by cinematographic films and other educational means the mysteries of the life-cycle of one of man's greatest foes, the measures taken to defeat it, and the results of a campaign well and truly waged.

Fuel Oil Resources of the Future.

By H. B. MILNER.

PUBLIC attention has once again been directed to the vital question of the world's resources of petroleum, in a paper read before the Institution of Petroleum Technologists by Prof. A. W. Nash and Mr. H. G. Shatwell on December 2, and further by a column having reference to that communication in the *Times* of December 3. The object of the paper is to allay uneasiness existing in the minds of many with regard to the adequacy of future oil resources.

The argument requires that before justifiable fears are entertained we must be satisfied that all free petroleum in the earth has been located, that the problem of the origin of petroleum has been solved, and that "oilfields can be discovered and not simply located as a result of surface workings by local inhabitants." Alternative to natural mineral oil are "the abundant stores of bituminous material from which oil can be obtained by destructive distillation," these being oil shales, cannel coals, torbanites, lignites, peat, and coal.

With regard to the first point, it is maintained that outside America the search for oil has not been carried on diligently, and the implication is that, following precedent in the history of the American oil industry, more fields should be developed in other countries. Then, the problem of the origin of petroleum not having been solved to general satisfaction, it is argued that it is impossible to state definitely that oil is not in process of formation at the present time. The third point is obscure both in definition and in amplification, though it is implied that improved technique is necessary in the initial stages of oil exploration. The arguments in favour of the development of alternative fuel resources are not new, though great stress is laid on the commercial possibilities of "berginisation" of coal and oil as a promising method of obtaining a substitute for natural petroleum.

It is difficult, despite the good case made out by the authors for peace of mind in connexion with future oil supply, to share fully their optimism, because while some agreement may be accorded with the facts they adduce in support of their opinions, their interpretation of the position and the conclusions they reach, since they are based on no new data, are open to question as much from economic as from technical points of view.

Misapprehension concerning the future of oil-fuel supplies was first of all felt and voiced, not by an irresponsible section of the community, but by experts both in the United States and in Europe, who realised the true drift of events. Far-sighted people, from an examination of the position from every angle—national, technical, economic—gradually came to see that if production did not keep pace with an ever-growing consumption, a most serious position would arise, probably within the course of two decades or so. Uneasiness spread, therefore, despite insistent press contradictions, instigated by interested persons, who did not hesitate to write up glowing accounts of a contemporary "oil age," and to quote misleading statistics to prove their optimistic contentions. Thus the industry and the public were entitled to an unbiassed knowledge of the facts, and also to considered and authoritative judgment on the position, either as a clear warning to be prepared for the worst, or as a vindication of the light-hearted optimism expressed in some quarters. The authors have therefore done well in bringing the matter once more to the front, even though we cannot agree with the reasons they consider sufficient to disarm fear for the future.

First, it is, we agree, reasonable to believe that all available petroleum has not yet been located; it would indeed be a poor outlook if this were so. But it is a question of magnitude of resources to be tapped, not merely the discovery of several comparatively small oil-pools. We have to ask ourselves whether, from broad geological knowledge of the world, there exist accessible regions outside the United States, where geological conditions are likely to favour the preservation of oil deposits on the vast scale which has made the industry in that country, and latterly in the world, what it is? Can we point to a second Pennsylvanian, Mid-Continent, or Californian region anywhere with any degree of scientific possibility? It is difficult to do so. It is, of course, possible to predict many localities likely to yield a future oil supply, on a par with, say, Persia, or Sarawak, at the present time, but it is not easy to visualise the existence of oil-pools the collective exploitation of which will determine an ultimate supply on the scale at present requisite, or likely to be demanded in the near future, if and when the United States with Mexico cease to yield 80 per cent. of the world's total output.

Secondly, we may agree with the authors that the mode of origin of petroleum still remains debatable, despite more than thirty years of philosophy, but even if the problem were solved to universal satisfaction to-morrow, would the knowledge lead us to the location of deposits at present forming, and would such deposits be likely to have immediate economic value even if they were found? Whatever theory be advanced to account for the origin and accumulation of petroleum, the geological time-factor seems to be an inevitable influence in the mechanism, and yet we are asked to contemplate the prospect of contemporary petroleum, ripe for use, if not just at the moment, at least within the next few decades! An accepted solution of the genesis of petroleum is desirable for many reasons—mainly scientific—but the immediate economic significance of such a solution if arrived at, as indicative of a new line of field-investigation, is difficult to follow.

Thirdly, the authors suggest that mere geological examination of potential oil-bearing territory is insufficient, and should be accompanied at the outset by a drilling staff "to drill for geological information and not for oil." Where is the philanthropic company which can be persuaded to finance such a proposition? Further, the platitude is expressed that the science of geology of petroleum is an inexact one; since geology itself cannot be classed as an exact science, obviously a particular application must, *a priori*, be inexact. But is it a whit more precise, as is implied, to encourage wholesale "wild-catting" of a kind which, while admittedly advisable from the purely technical aspect of field-geology, might only result in more failures to find oil, certainly in a heavier initial expenditure which the average company director would never agree to incur, not even in these enlightened days of intelligent directorates ? If the geologist is to be of any use at all in locating oil deposits, his work must precede exploratory drilling, for economic, if for no other reasons.

The authors also review the existing position of oil supply and mention more particularly possibilities in Persia. In this connexion, while sharing their opinion, we may be allowed the remark that even if Persia doubles her production in the next year or two, it would only represent 5 per cent. of the world's output at the present rate. They also stress the potentialities of the Canadian Athabasca tar-sands, a proper utilisation of only 25 per cent. of which would, they say, remove apprehension regarding the future. We refer them to the recent report by S. C. Ells (Bituminous Sands of Northern Alberta, 1924), in which he states (in reference to tar-springs) that " in no instances are they themselves of commercial value as a source of bitumen. They have, at times, been regarded erroneously as a definite indication of the presence of petroleum pools." Later, summarising several processes devised for producing oil from these tar-sands, he says, "The results of this work are as yet inconclusive."

A further " off-set " to shortage of supply is the possibility of mining for recoverable oil from abandoned oil-fields by shafts and galleries, as at Pechelbronn ; this principle, apart from the human factors involved, may be economic with shallow sands in some cases, but what of oil-sands lying between 3000 and 5000 feet below the surface : would the method be practicable, and does it therefore help the solution of the difficulty ?

Lastly, we reach the question of alternative fuel resources, and here, while the authors are to be congratulated on the way they have marshalled the possibilities of shales and coals, they should in fairness have laid more stress on the technical difficulties at present in the way of utilising these resources on a satisfactory commercial scale. The world's known resources of oil-shale are now generally appreciated, but the estimates given by Alderson and others as to the amount of oil recoverable from them are quite fictitious until suitable retorts and processes are devised for treating them economically, while apart from any other difficulty, desulphurisation of shale-oil and high refining losses still remain in many cases thorny impediments to development, as in Great Britain.

The difficulties concerned with coal and allied carbonaceous material as a source of oil are similarly those concerned with large-scale treatment for commercial supply. Low temperature carbonisation is, from the economic point of view, a process which has yet to be extended under modern conditions of fuel supply and efficiency. Even if successful, oil thus obtained, as the authors admit, can never adequately replace petroleum products. The " berginisation " of coal and oil, regarded by the authors as being of great promise, is in an experimental stage, and much ground has yet to be covered before the application is a practicable one from a commercial point of view. This process consists in heating in the presence of hydrogen a mixture of powdered coal containing less than 85 per cent. of carbon, with mineral oil or tar oil at high pressure (100 atm.) and temperature (400°-430° C.), when a liquid product closely resembling petroleum results. It may be pointed out that unless the liquid product is capable on refinement of yielding a range of products which will take the place of petrol, kerosene, lubricating oil and fuel oil, the process loses at once in value as a means of producing artificial fuels. At present we have little trustworthy data concerning either the refinement or the quality of such " berginised " oil.

Thus the whole question remains in an unsatisfactory position, and it cannot be said that a critical examination of the authors' thesis advances things much further. We endorse, as every student of science will do, their insistence on the need for research, not only for posterity, but also for our own sakes. Conservation of petroleum resources will automatically come, whether we urge it or not, since for strategic reasons alone the United States will ultimately have to limit its exports of oil, and that, too, within the next two decades, if further large supplies are not forthcoming. Once the United States decides on that policy, Europe and all other countries dependent on it for the larger proportion of their oil-fuel requirements will have to face the inevitable, and either economise in the use of petrol and petroleum products, or provide some alternative, but probably in the long run, far less convenient fuels and lubricants.

Hence the keynote to the situation may be summed up in the word economy. The present heavy-handed use of petroleum results from a general impression that there is plenty more where the present supply comes from, an extravagant idea inculcated by the same policy responsible for recent deplorable overproduction and wasteful consumption. If the industry, by adopting in the future the practice of husbanding existing resources and by straining every scientific nerve to a higher technique in production, refinement and utilisation of oil-fuel, thus sets the example to the public, the public itself will be educated. Decline in cumulative production in such circumstances will be slow ; the full and beneficial effect of each new discovery of an oil-pool, however small, will also have time to operate, and the gaining of time in one way means that the chances of developing new schemes of alternative fuels, as outlined by the authors, are more likely to meet with success, at all events as commercial propositions.

Some people hold that we should enjoy the gift bestowed on our own generation, the privilege of living in an " oil age," and leave posterity to take care of itself. This is neither a credit to contemporary knowledge, nor is it in keeping with the best traditions of scientific progress. We owe it to ourselves to face the situation as repeatedly exposed by David White, Pogue, and others qualified to judge, and whatever position may ultimately be created by a shortage of natural petroleum, we have to see that we are not unprepared to meet the contingency either through lack of foresight or of initiative in perfecting substitutes. But we have also to realise that the prospect of supplanting petroleum by alternative, artificial fuels is confined largely to the realm of experimental possibilities ; merely to define the possibilities is not necessarily to remove the qualms which still exist in the minds of not a small section of workers in the oil industry.

Current Topics and Events.

IT is a biological commonplace that every species of animal (man included) tends to increase in numbers if left free to propagate without restraint. This restraint is, however, always forthcoming when the population reaches a certain degree of saturation, and in the case of the human race it has in the past taken three forms, namely, war, famine, and pestilence. During the fourteenth century there were seven famines in England, in which the people died like flies, and towards the close of the century the Black Death wiped out three-quarters of the population. We are familiar with the ravages of the Great Plague in London in 1666, during which 100,000 people died, but few realise that in the preceding century there were two similar visitations, and in the earlier one, which occurred in Elizabeth's reign, 65,000 people died. The Queen and Court fled to Windsor, and the Queen had a gallows erected in the market-place, and gave orders that every Londoner who appeared in the town should be hanged!

WITH the development of our social sense, which is the real measure of our advance in civilisation, the suffering and sorrow involved in these calamities have become abhorrent to us; and a certain proportion of our population, chiefly the better educated members of it, have learned so to limit their families that they are able to give to each child its proper share of care, food, and affection. But the greater part of the population, including most of the manual workers, are without this knowledge; and amongst them the lowest, poorest paid, and least skilled are the most prolific. The Walworth Women's Welfare Centre (153A East Street, Walworth, S.E.), the annual report of which has recently been received, was established with the object of teaching the poorer women harmless means of preventing conception, so that the births may be properly spaced and the children given a chance of healthy development. A distinguished Dutch medical man, Dr. Jansen, in a book entitled "Feebleness of Growth," has given reason to believe that in successive children produced by rapidly succeeding pregnancies, there is a progressive physical degeneration manifesting itself in stunted growth and deformities of various kinds. It would seem that birth-control should ultimately replace natural selection as a limiting factor in human affairs: but if it is confined as at present to the best elements of the population, it must cause the deterioration of the quality of the race. The aim of the Walworth centre and of the newly established centre in North Kensington is to spread the knowledge amongst those who need it most.

THOUGH to-day some 2,000,000 tons of shipping are propelled by internal combustion engines of the Diesel type, a new chapter in the history of the motor ship may be said to have been opened with the recent trials of the M.S. *Oorangi* built by the Fairfield Shipbuilding and Engineering Company of Govan for the Union Steamship Company of New Zealand. The *Oorangi* (the name is the Maori for Mount Cook) is the first large and fast passenger vessel to be fitted with Diesel engines. The ship is 23,000 tons displacement, 600 feet long by 72 feet beam, and will carry about 1300 passengers and crew and a considerable amount of cargo. It is designed for the long run from Vancouver to New Zealand and Australia, on which it is expected that an average speed of 17½ knots will be maintained. The main interest lies in the vessel's machinery. There are many types of Diesel engines being produced to-day, but the engines of the *Oorangi* are of the Sulzer type, two-stroke, single-acting, as developed by the famous Swiss firm of Sulzer Brothers of Winterthur. There are four sets of main engines driving four shafts, each set having six cylinders 27½ inches diameter, 39 inches stroke, the whole 24 cylinders developing some 15,000 B.H.P., equivalent to 19,750 I.H.P. The air compressors for supplying the air, at 1000 lb. pressure, for injecting the fuel are worked off the main engines, while the low-pressure air supply for scavenging is obtained from three turbo-blowers driven by electro motors. There are also two electro motor-driven high-pressure air compressors for supplying the starting air when manœuvring in and out of port, while the electric power installation for the ship consists of four 350 kw. generators driven by Sulzer-Diesel engines of 420 B.H.P. Some of the auxiliaries in the ship, such as the refrigerators and winches, are driven by steam supplied from two ordinary marine boilers burning oil. The ship carries about 3000 tons of oil fuel, which is sufficient for the round voyage between Vancouver and Sydney. As pointed out by Engineer-Admiral Sir George Goodwin in his Hawksley Lecture to the Institution of Mechanical Engineers on November 7, there are many considerations to be taken into account when deciding upon the type of machinery for any particular ship, and the performances of the *Oorangi* at sea will be followed with great interest.

THE value of an international language for promoting amity among nations, and its obvious advantages for use in international trade, have been much emphasised by those who are convinced of the practicability of such a project; but its presumptive value to men of science has, perhaps, not yet received due attention. The work of a large number of scientific and technical societies is severely handicapped by the greatly increased costs of printing and publication, and the adoption of a single language for communicating abstracts from scientific literature, as well as for papers and treatises of exceptional importance, would undoubtedly effect economies in money and effort. In a recent issue of the Proceedings of the American Philosophical Society (vol. lxiii., No. 1), Prof. R. G. Kent, of the University of Pennsylvania, makes a thoughtful contribution to this subject. After referring to the use of Latin by scientific investigators from about A.D. 1500 until 1775, and to the recrudescence of national feeling and national languages since the War, the author declares that the language burden has now become too great even for the professional philologist and *littérateur*. He discusses the merits of the chief languages that have been suggested for international use, and comes to the conclusion that Latin is best for scientific purposes. Latin has a vocabulary that is essentially international, and a technical terminology which is already very wide and capable of easy and indefinite extension. Although ease of acquirement and brevity are valuable characteristics of an international language, a recognised and unquestioned standard of meaning is even more important. Latin has an objective standard of word-meaning, and by reason of its terminations, word-order, and moderate use of auxiliaries, it allows of complete precision in indicating the relations of words to one another; it is reasonably phonetic; it is still used for constructing new words required in science; of all non-native languages, it is most studied in European and American schools; and its use would not inflame international jealousy. Prof. Kent advocates the use of a simple Latin, *i.e.* one with short sentences and few clauses, together with a slightly increased number of prepositions. Thus modified, he thinks that Latin would stand supreme as a means of conveying scientific thought to an international public.

AT the last meeting of the Newcomen Society held on December 17, another valuable contribution was made to the early history of mechanical engineering by Mr. Forward in a paper on "The Early History of the Cylinder Boring Machine." The lathe, the planing machine, and the boring machine have all been developed into very powerful and accurate machines, but some of their principal features can be traced back to the pioneering machines. It was the steam engines of Newcomen, Smeaton and Watt which created the demand for cylinder-boring machines, and one of the first is that described by Smeaton as seen at the Carron Ironworks, but it was as imperfect as Watt's "Beelzebub" itself. It was the well-known ironmaster John Wilkinson who first used a long stiff cylindrical bar fitted in bearings and provided with a cutter head of large size which could be traversed along the bar by means of a rack and pinions. It is possible the old boring bar at the Science Museum, South Kensington, was one of Wilkinson's earliest and was used at Bersham. Another improvement was the use of a screw instead of the rack, but it is not certain who made this important addition. Among the engineers of that day was Matthew Murray of Leeds, and it may have been due to him. In speaking of the making of the screws, Mr. Forward quotes an interesting passage from T. Gill's "Technological and Microscopical Repository" of 1830, showing how the lines for the screw were first produced on the bar, how a shallow screw thread was cut by hand, and how this shallow screw was used for completing the cutting.

A REPORT by Mr. Leslie Armstrong on recent results obtained by the joint committee of the British Association and the Royal Anthropological Institute for the exploration of caves in Derbyshire appeared in the *Times* of December 22. An undisturbed occupation site at Creswell Crags, opposite a cave, known as Mother Grundy's Parlour, at the eastern end of the ravine, has yielded rude implements of quartzite, more than 1500 flint flakes and implements, a number of bone tools, and numerous bones of pleistocene animals. More important, however, are examples of palæolithic art in the form of engraved bones, one a spirited drawing of a reindeer, another a part of a bison with the head, and a third fragment too small for identification. The only other undoubted example of palæolithic cave engraving from Britain is that of a horse's head from the Robin Hood Cave, also at Creswell, found by Sir W. Boyd Dawkins in 1876. The earliest implements—flakes and hand-axes made from quartzite pebbles of late Acheulean form—were associated with remains of cave lion, cave bear, and hyæna. They represent not only the earliest occupation of Creswell, but also the extreme northward extension of early palæolithic man in Britain. A considerable interval elapsed between this and the next occupation, which belongs to the Reindeer Period. In this stratum were flint tools of Upper Aurignacian type, the engraved fragments of bone, and tools manufactured from reindeer antler and bone. A hearth or fire-hole was scooped out in the basement bed and ringed with flat stones. Not only does the evidence from the cave earth here indicate continuous occupation from late Aurignacian to Azilio-Tardenoisian times, but it also supports the view which challenges the existence of true Magdalenian culture in Britain, and maintains that there was an independent development of culture here which was free from intrusive Magdalenian influence.

THE December issue of *La Science Moderne* contains an article by M. Reverchon on "L'Evolution de l'Horlogerie." M. Reverchon points out that the mechanical clock was the gift of the middle ages, and its development belongs to the last six hundred years. One of the first clocks made was that constructed for the Cathedral of Beauvais, but the oldest clock still going is that in the Science Museum at Kensington. The fourteenth century saw many cathedrals supplied with clocks. All of these were fitted with the verge escapement—the first of all escapements—the inventor of which is unknown. "Nous sommes ainsi reduits à le saluer comme le soldat inconnu de la chronométrie." The verge escapement was the only one used for three and a half centuries, and even the pendulum clock presented by Huygens to the States General of Holland had it. A little later came the anchor escapement of Hooke or Clements, and then others by Graham, Le Roy, Lepaute, Mudge, and others. In his sketch, the author divides the history of the clock into three periods, the second of which opens with the work of Huygens, while the third, "the scientific period," began with the work of Edouard Phillips, who in 1861 published his essay "Mémoire sur le spiral réglant."

MARINE meteorology is dealt with in the *Marine Observer* for December published by the Meteorological Office, Air Ministry; this completes Vol. I., which commenced with 1924. The publication emanates from the Marine Division; communications are contributed by the marine staff, and interesting items are given by the voluntary marine observers, for whose benefit the work is primarily undertaken. "Wireless and Weather, an Aid to Navigation," has been made a special feature throughout the year, and the December number is of special interest to seamen, dealing with phenomena common to the Atlantic and Pacific Oceans. A quotation is given from "Physical Geography of the Sea and its Meteorology," written by Maury about sixty years ago, given apparently to show that over the open ocean there are no interfering causes as commonly exist over land. With our present knowledge of the weather, the North Atlantic with its cold Arctic current flowing southwards and the Gulf Stream flowing northwards, together with other interfering causes, it is not easy to admit that over the ocean "the agents which are at work are of a more uniform character." Synchronous weather charts are given, drawn at sea from wireless reports received, and these will prove very helpful to other observers wishing to obtain similar information. It is only recently that it has been possible to draw weather charts at sea, of similar use and with somewhat equal accuracy to the synchronous charts drawn on shore at special weather bureaux. A retrospect of the results given in the first volume and the interest in the work taken by seamen is said to justify the continuance of the publication. Without doubt marine observers are regaining their pre-War interest in meteorology.

AT the twelfth annual meeting of the Indian Science Congress to be held at Benares under the auspices of the Benares Hindu University on January 12-17, His Highness the Maharajah of Benares will be the patron and Dr. M. O. Forster, Director of the Indian Institute of Science, Bangalore, will be the president. The Sections and their presidents are as follows:—*Agriculture*, R. S. Finlow, Director of Agriculture, Bengal, Dacca; *Physics and Mathematics*, Prof. E. P. Metcalfe, Principal, Central College, Bangalore; *Chemistry*, Dr. J. C. Ghosh, University professor of chemistry, Dacca; *Zoology*, Dr. Baini Prasad, Officiating Director, Zoological Survey of India, Calcutta; *Botany*, Prof. R. S. Inamdar, University professor of botany, Benares Hindu University; *Geology*, Dr. G. E. Pilgrim, Superintendent, Geological Survey of India, Calcutta; *Anthropology*, Prof. P. C. Mahalanobis, Presidency College, Calcutta; *Medical Research*, Lieut.-Col. F. P. Mackie, Director of the Bombay Bacteriological Laboratory; *Psychology*, Dr. N. N. Sen Gupta, professor of psychology, Calcutta University. Besides the usual sectional programme, general discussions have been arranged on the following topics: The physical and chemical aspects of valency; the true path of industrial development in India; the relation of insects to disease in man, animals and plants; the fauna and flora of Krusadai Island near Rameshwaran. Popular evening lectures will be delivered by Prof. A. J. Turner, on "Science and the Cotton Industry"; by Dr. S. N. Gore, on "Bacterial Flora of Drinking Water in India"; and by Prof. P. Sampat Iyengar, on "The Growth of India." Lieut.-Col. F. P. Mackie will give a cinema demonstration on malaria and kindred subjects. A number of excursions and social functions are also being arranged in connexion with the Congress.

SIR OLIVER LODGE has accepted the presidency of the Radio Society of Great Britain in succession to Dr. W. H. Eccles, who has held the office for the past two years.

WE much regret to record the death on December 26 of Dr. G. D. Liveing, F.R.S., president of St. John's College, and formerly professor of chemistry in the University of Cambridge. Dr. Liveing, who reached the advanced age of ninety-seven years on December 21 last, was the victim of an accident some two months ago and he never recovered. His early work was chiefly in the domain of spectroscopy, and he was awarded the Davy Medal of the Royal Society for his contributions to that subject so long ago as 1901.

PROF. E. GOURSAT, of the faculty of science of the University of Paris, and Prof. L. Bianchi, professor of analytical geometry in the University of Pisa, have been elected associates of the section of mathematical and physical science of the Académie royale de Belgique (Classe des Sciences); and the Lamarck Prize (Zoology) has been awarded to Prof. E. Chatton, professor of general biology in the University of Strasbourg.

THE University of Sydney commemorated on October 23 last the centenary of the publication of Sadi Carnot's "Réflexions sur la puissance motrice du feu." Representatives of almost all the scientific and educational institutions of Australia were present at the commemoration. Lectures on the bearing of Carnot's work on modern science and industry were delivered by Sir Henry Barraclough and Prof. O. U. Vonwiller, and exhibitions and demonstrations of modern oil, gas, and steam engines and refrigerating machinery were given in the Engineering Laboratory of the University.

IN conjunction with the Meteorological Office, Mr. S. Morris Bower, Langley Terrace, Huddersfield, purposes to continue, during this season (January 1–March 31), the annual record of winter thunderstorms in Great Britain hitherto made by Mr. C. J. P. Cave, of Petersfield (see NATURE, December 30, 1922, p. 877). Reports from all parts of the country are desired, especially from Scotland, Ireland and the North of England.

THE last meeting of the Illuminating Engineering Society was held at the E.L.M.A. Lighting Service Bureau—an interesting departure with the view of bringing practice and theory into line. Visitors, including representatives of gas lighting interests, had an opportunity of witnessing demonstrations of the latest types of lighting units and examining critically methods of impressing the benefits of good lighting on the public. Some of the appliances shown illustrated aptly the application of scientific principles in the lighting industry, and there was one device, a new form of camera shown by Dr. Rosenthal, that excited considerable interest. This compact form of camera is expressly designed for taking photographs by artificial light and is provided with an exceptionally large aperture. It was stated that an exposure of two seconds was sufficient with illuminations not less than 5 foot-candles—a speed that would easily enable photographs of artificial lighting installations to be taken with figures in the foreground. In the case of factories, this is likely to be a considerable advantage.

KING EDWARD'S HOSPITAL FUND for London has arranged a series of evening popular science lectures, by distinguished scientific workers, during January, February, and March. The lectures are to be given at the Imperial College of Science and Technology, King's College, Birkbeck College, and various polytechnics spread over London, and the proceeds go to the Hospital Fund. Sufficient guarantee of the interest of the lectures is given by the list of lecturers: Sir Sidney Harmer, Sir Richard Paget, Bart., Sir Robert Robertson, Profs. Winifred Cullis, A. O. Rankine, S. Chapman, E. W. MacBride, C. S. Myers, G. Elliot Smith, E. N. da C. Andrade, J. S. S. Brame, F. J. Cheshire, and Leonard Hill, Mr. W. E. Garner, Mr. C. R. Darling, Capt. P. P. Eckersley, and Major R. W. Mayo. Tickets can be obtained from the secretary of the institution at which a lecture is to be held, or from the secretary of King Edward's Hospital Fund for London, 7 Walbrook, E.C.4 (price 1*s.*); serial tickets, available for any number of the lectures (price 4*s.*), can also be obtained at the latter address. Admission is by ticket or payment at the entrance.

"THE Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Company" is in future to be issued annually because of the increasing number of the publications that have to be dealt with. The seventh volume that has just been received gives, in a slightly abridged form, the 22 papers that were printed during 1923 in various English, American, and French scientific journals. The full reference is given to the original source in each case, so that any one specially interested in any particular paper may refer to the full communication. The abridgments are classified under the headings of physical optics, photographic optics, inorganic, organic, physical and colloid, and analytical chemistry, photographic theory, and practical photography. They carry forward the work for which this Laboratory has become so well known.

THE Cambridge University Press announces for early publication "Scientific Papers," by the late S. B. McLaren, dealing mainly with electrodynamics and natural radiation. The work has been prepared for publication by Profs. H. H. Hassé, T. H. Havelock, J. W. Nicholson, and Sir Joseph Larmor. The same firm also announces "Plant Life on East Anglian Heaths," by Dr. E. P. Farrow. The volume will contain an account of some observations, problems and experimental work relating to the ecology of the vegetation of the East Anglican heath district known as the "Breck Country."

"THE Scientists' Reference Book and Diary," published by Messrs. Jas. Woolley, Sons and Co., Ltd., 76 Deansgate, Manchester, is as attractive and handy a book as any scientific worker could desire. It includes useful information, constants, and conversion tables, relating to many branches of science, lists of universities and scientific institutions, mathematical tables, and much other matter, in addition to a diary for 1925 and several detachable pages of squared paper. The price of the publication is 3*s.* 6*d.*, and we can confidently recommend this twenty-seventh issue to all science teachers and students.

Our Astronomical Column.

A NEW COMET?—A telegram from the Copenhagen Astronomical Bureau announces the discovery of a nebulous object by Prof. Wolf at Königstuhl Observatory on Dec. 23^d 8^h $15{\cdot}7^m$ G.M.T. Its R.A. was 4^h 8^m $19{\cdot}47^s$; N. Decl. 24° 31′ 36″ (referred to equinox of 1924·0); daily motion $-28^{\text{sec.}}$, south 14′; magnitude 16·0.

Two plates were exposed by Mr. G. Merton with the 30-inch reflector at Greenwich on Dec. 26, but up to the present, the object has not been located upon them. It is clearly beyond the reach of ordinary instruments.

VARIATION OF LATITUDE.—The *Japanese Journal of Astronomy and Geophysics*, Vol. 2, No. 3, contains a discussion by H. Kimura of the results obtained at the international latitude stations, Mizusawa, Carloforte, and Ukiah, in the last two years. The star-places and proper motions have been rediscussed; the amplitude of the combined wave during the period discussed is about 0·2″, that of the *z* or Kimura term about 0·05″.

The author concludes that there is a 19-year term in the variation, and that the following sub-multiples of this period have sensible coefficients: $\frac{19}{20}$, $\frac{19}{19}$, $\frac{19}{18}$, $\frac{19}{17}$, $\frac{19}{16}$, $\frac{19}{15}$, $\frac{19}{14}$. The second and fifth have the largest coefficients. These are the well-known annual and 14-month terms. He further believes that terms found in earthquake analysis appear also in the polar motion, indicating a close connexion between the phenomena.

CONVECTION CURRENTS IN THE ATMOSPHERES OF THE SUN AND STARS.—The Proceedings of the National Academy of Science, Washington, for September 1924 contains a paper by C. E. St. John and H. D. Babcock on this subject. They confirm previous conclusions that the pressure is a small fraction of an atmosphere, being 10^{-1} atm. at the photospheric level, 10^{-4} at 5000 km., and 10^{-13} at 14,000 km. The daily rotations at these heights are 13·84°, 14·44°, 15·4°, and the linear velocities 1·97, 2·06, 2·18 km./sec. The convection currents are downward 0·5 km./sec. at 14,000 km., downward 0·3 km./sec. at 1500 km., and upward 0·3 km./sec. near the photosphere. The authors have made a similar examination of the spectra of Sirius, Procyon, and Arcturus; they conclude that the difference of convection speed for high level minus low level increases with temperature, being 1·20 km./sec. for Sirius, type A, 0·67 for Procyon, type F, and 0·34 for Arcturus, type K. It may well amount to 4 km./sec. for type B, which would explain the well-known "K" term for these stars. The pressures in the atmospheres of Sirius, Procyon, and Arcturus are concluded to be of the same order as that in the sun; the largest value found is 0·4 atm.

Research Items.

HEREDITY IN FINGER PRINTS.—Attention was first directed to the indications of heredity in papillary ridges by Galton, upon whose investigations our knowledge of finger prints is based. His evidence on this point consisted of a statistical treatment of 150 fraternal couplets, an investigation of 17 sets of twins, and a comparison of children with their parents when both parents were like patterned. Galton himself pointed out that the number of his cases was too few to justify quantitative conclusions. The question has been investigated further by later workers, of whom the most recent is Mlle. Kristine Bonnevie, of the University of Kristiania, who has had the finger prints of the Court of Justice of Kristiania placed at her disposal. This material covers 24,578 Norwegian criminals. The result of an examination of these data is published in the *Journal of Genetics*, vol. 15, pt. 1. The statistical investigation follows Galton's results very closely, showing a percentage for all fingers :—whorls 25·65, radial loops 5·81, ulnar loops 61·14, and arches 7·4, the distribution being characteristic for all fingers. A comparison with material from other races showed the total numerical occurrence of each pattern type to be characteristic of each race investigated, while the distribution of each type upon the various fingers showed in all races the same characteristics as in the Norwegian material. Among other conclusions of considerable importance, a number derived from data furnished by related individuals clearly suggest that finger patterns are hereditary. Further, there is seen to be a causal connexion between the appearance of the patterns and the shape of each finger-ball.

THE CULTURE OF THE NEWARS.—The Newars form the most numerous group of the inhabitants of the Valley of Nepal proper, and afford an interesting example of the effect of a fusion of cultures—a point of view from which they have been studied by Mr. K. P. Chattopadhyay in a communication in the Journal of the Asiatic Society of Bengal, N.S. vol. xix. pt. 10. They are divided into the Bauddhamārgis who worship Buddha, and the Sivamārgis who worship Siva ; but since their conquest by the Gurkhas, who entered Nepal in 1768, the former have, under the encouragement of their conquerors, lost ground to the latter, who may be termed Hindus, and have an organisation similar to that of the Hindus of the plains, though of a simpler character. The Bauddhamārgis are divided into three grades. A peculiarity of the castes is that most have a religious duty to perform at the festivals, and are as much religious organisations as social. Among the Hindu Newars, the only definite secular occupation followed by any caste except fighting, trade, and cultivation, is that of cowherds. All other occupations are followed by pure and mixed Bauddhas. It is clear that the employment of cattle was not known to the Newars in ancient times, and even now is comparatively rare. Before the knowledge of cattle was introduced to Nepal, a culture characterised by knowledge of metal, wood and stone working, as well as hoe cultivation of a peculiar type, existed, and must have come from elsewhere, being imposed on a country inhabited by rude and wild tribes. An analysis of religion, social organisation, and arts and crafts indicates that this early culture came from India, and not Tibet as has been suggested. This was followed by a later Brahmanic conquest or incursion with a culture not strikingly superior to that of Nepal, into which it was assimilated. It differed in type from that Brahmanic civilisation which affected the Gurkhas.

BRITISH FOSSIL ELEPHANTS.—In *La Nature* for November 15 (No. 2641), Dr. Georges Pontier gives an account of his researches on the British fossil elephants. He figures selected specimens attributed to *Elephas planifrons*, *E. meridionalis*, *E. antiquus*, *E. priscus*, *E. trogomtherii* and two forms of *E. primigenius*. In a table at the end he sums up his views of the evolution of the group as exemplified by the British forms, and in these views he follows very closely those of Depèret and Mayet, whose paper published in *La Nature* for August 25, 1923 (No. 2577) has already been noticed in these columns (NATURE, September 15, 1923, p. 405). While the view, which we owe to Depèret and Mayet, that the various species of elephants form separate lines, with little or no connexion with one another ; that, for example, *E. planifrons* gave rise to *E. meridionalis* and its mutations only ; that *E. antiquus* is separate from it and so on, is a view which is attractive and easy of comprehension, it is nevertheless not entirely borne out by a closer survey of all the material in the numerous large collections in Great Britain. It takes no account of the many apparent intergradations of the pattern and other characters of the molar teeth which have led many other authors to the different conclusion that there is much interrelationship. It places also too great a reliance on the supposed correctness of the sequence in time of the described mutations, some of which can be shown to occur in England in the same beds instead of appearing in subsequent strata. The paper, however, forms an interesting and valuable contribution to a very perplexing problem.

NORTH AMERICAN MAMMALS.—Mr. G. S. Miller has a two-fold object in drawing up his List of North American Recent Mammals, 1923 (Bull. U.S. Nat. Mus., No. 128) : to direct attention to the richness of the United States National Museum collections, and to furnish a summary of the systematic results of the study of North American mammals to the end of the year 1923. The stupendous nature of Mr. Miller's task may be gauged from the fact that the United States National Museum collections contain 166,000 skins, three-quarters of which have been brought together by the United States Biological Survey, to the work of which Mr. Miller pays full tribute. The completeness of the collections may be judged when it is remembered that out of 2554 forms represented in North America, only 171, or less than 7 per cent., are absent from the national collections, while the number of types at the disposal of the author was 1435. Mr. Miller has furnished under each species or sub-species a reference to the first publication of the name, or to the publication in which it was first admitted to the North American list, and he has correlated his nomenclature with previously published lists. Under each form the type locality is given with great exactitude, and the known range briefly indicated. Mr. Miller's paper will be an invaluable work of reference for all engaged in the study of mammalogy.

A PROBLEMATICAL ORGAN IN THE LAMPREY.—Mr. G. R. de Beer (*Jour. Anat.*, vol. lix. pt. 1, pp. 97-107, October 1924) has investigated the problematical organ in the olfactory capsule of Petromyzon first made known by W. B. Scott, and the subject of much speculation by subsequent workers. The organ is vesicular, the vesicles being closed, lined with ciliated glandular cells, containing fluid, and immersed in blood sinuses innervated by branches of the olfactory nerve. The diverticula from which the vesicles arise in the larva contain secreted (excreted) matter, and the fluid in the adult vesicles is evacuated through the blood. There is not sufficient evidence to indicate the homologies of the organ, but the author thinks the evidence not strong enough to warrant the suggestion that it is the homologue of Jacobsen's organ. He inclines to the view that it is a gland, possibly endocrinal in nature, the secretion being carried away in the blood sinuses with which it is surrounded. Experimental tests with extracts from the organ give negative pituitary reactions. No similar organ was found in the allied genera Myxine or Bdellostoma.

A DEVONIAN PLANT WITH ALGAL ORGANISATION AND TETRADS OF RESISTANT SPORES.—This interesting conjunction of characters seems to be present in *Sporocarpon furcatum*, a fossil plant from the black shale of the Devonian strata of Ohio, first described by Sir William Dawson, who saw in these saccate, flattened pellicles, the compressed remains of the sporocarps of some unknown plant. The late Dr. R. Kidston and Prof. W. H. Lang now report, in the Transaction of the Roy. Soc. of Edinburgh, vol. 53, pp. 597-601, the finding of tetrads of spores in specimens of this plant. The authors conclude that the mode of occurrence, general appearance, and structure of the specimens strongly suggest that they are the more persistent tips of some thalloid Alga of the period. The disposition of these spore tetrads might be paralleled among living Rhodophyceae, but the resistant nature of the thick wall of the spores and the presence of surface marking corresponding to the place of contact of the spores then become features of extraordinary interest, as they are not found in any known Alga.

THE IMMUNITY OF APPLE STOCKS FROM WOOLLY APHIS.—In the *Bulletin of Entomological Research* for November 1924 (vol. xv. pp. 157-170), Mr. L. N. Staniland attempts to explain this immunity in certain apple stocks. It is well known that the woolly aphis induces gall formation on its host plant, and Mr. Staniland remarks that the cambium is affected, almost certainly by the salivary secretion of the insect, in such a way that each of its cells divides more rapidly than normally, thus producing the gall tissue. Later, the medullary rays are affected and also contribute to gall formation. The occurrence of sclerenchyma in the host-plant plays an important part in relation to the susceptibility of different varieties of apple to woolly aphis attack. The chances of the stylets of the aphid reaching a point near to the cambium bear a definite relation to the degree of development of the prohibiting factor, sclerenchyma. The latter tissue, to a large extent, affords a barrier to the passage of the stylets. There is also a definite relation between the possibilities of penetration and the number of thin-walled "penetration areas" between the masses of sclerenchyma. When the masses of the latter are large, and the softer penetration areas between them are reduced to a minimum, the chances of successful attack are enormously reduced. Among the varieties of apple studied it was found that a series arranged according to degree of susceptibility of attack largely corresponds with one arranged in order of the completeness of the development of the sclerenchyma ring.

GEOLOGY OF THE GOBI.—The geological results of the Asiatic Expeditions of the American Museum of Natural History include a detailed study of the basin structures of Mongolia, a first instalment of which is presented by C. P. Berkey and F. K. Morris in the Bull. Am. Mus. Nat. Hist., vol. li., 1924, pp. 103-127. Between the Arctic and the Pacific divides lies the Gobi Basin, a down-warped plateau bounded by rims that stand some 3000 feet above its average level. Within it are many minor basins that the authors distinguish by the term *talas* (Mongol for "open steppelands"). Each of these in turn contains still smaller basins which are the *gobis* proper of the Mongols. The basement rocks make up a deformed complex that probably corresponds on the whole to the Archæan of other lands, and in particular to the T'ai Shan complex of China. Above these there are probable representatives of the Middle and Upper pre-Cambrian, and all are cut by an immense bathylith. Next come infolded remnants of Carboniferous and Permian marine sediments, and a more extensive series of continental clastics that seem to be of Lower Jurassic age. All these older formations were strongly folded and worn down to a mature peneplain before the nearly horizontal basin sediments were deposited. These belong to the Cretaceous and Tertiary, and represent a continuation of continental conditions that have persisted right down to the present day. Two types of Gobi basins are recognised: one characterised by a faulted margin on the south, where the basins abut against the fault-block ranges of the Eastern Altai; and the other by simple down-warping in the less disturbed areas. The faulted basins contain lavas and a much greater thickness of sediments than the warped basins; but in both types sedimentation was intermittent, and in any one basin long intervals are unrepresented by deposits. The Miocene, for example, is almost completely absent from vast areas of Asia. On the whole, then, the Angara-Gobia continent seems to have been stable for long periods, and to have suffered regional denudation ever since the (?) Jurassic folding. Complementary sedimentation within its own borders is registered only where gentle warping and marginal faulting provided temporary collecting basins.

AUSTRALIAN CHINA CLAYS.—Australia has large deposits of china clay, and a report has been prepared on their different qualities ("Australian Clays in the Manufacture of White Pottery Wares," by R. C. Callister, Bull. 27, Institute of Science and Industry, Commonwealth of Australia, Melbourne, 1924). The results are presumably of a preliminary character. Most of the china clay employed in the work was from Lal Lal, and it is said that in this locality "very large quantities were available of a very uniform composition; later it was proved that this uniformity was further increased" when the material from the top was not mixed with that from below, but analyses justifying these statements are not included. The ultimate composition is not far removed from that of some of the English china clays. The statement that the osmose process of purification has been condemned in America, may convey a wrong impression. Very elaborate and expensive trials on the process have also been made by the British Refractories Research Association, and a few extracts from the report were indicated by Mr. S. R. Hind in the *Gas Journal* (Supplement, July 9, 1924). The net result showed that the expense did not justify the results obtained by this mode of purifying fireclays. Several countries have deposits of good china clay near at hand, and yet many manufacturers prefer to import the Cornish clays, *e.g.* Germany, the United States, etc. Manufacturers have stated that they prefer Cornish clays because (i.) their uniformity can be depended upon from year to year; and (ii.) with other clays there are small losses in manufacture which are a constant and irritating dead-charge on the output. It is to be hoped that the Australian china clays will prove an exception.

AUSTRIAN METEOROLOGY.—In the year-book for 1920 of the Zentralanstalt für Meteorologie und Geodynamik in Vienna, Dr. F. M. Exner directs attention to the number and distribution of meteorological observatories in Austria. There are now 86 observatories, of which 16 are of the first class. The year-book gives the full daily observations at Feldkirch, Salzburg, Sonnblick, Vienna, Graz and Obir, and the monthly and year means for all stations. Further tables give additional data for Vienna from self-registering instruments, while the final section gives the records of air movements derived from pilot balloons at Vienna in 1919 and 1920, to which are added some data from the Hochobir observatory in Carinthia at an elevation of 6700 feet.

FREQUENCY OF HEAVY RAIN IN INDIA.—Memoirs of the Indian Meteorological Department, vol. xxiii. pt. 8, gives much valuable data by Sir Gilbert T. Walker, who was until recently Director-General of Observatories. The object of the discussion is to supply engineering and other projects dependent upon rainfall with trustworthy information regarding both the frequency of heavy rain over various districts of India and the maximum amount of rain to be expected within definite short periods. The observations are for all rain-gauge stations maintained during the period of 30 years from 1891 to 1920, using data only where records are available for at least 10 years, and the number of years is stated. The falls are given for 24 hours, ending at 8 A.M., for the amounts of 3 to 4 inches, 4 to 5, and for each inch to 15 inches, while information of falls exceeding 15 inches in 24 hours is given as footnotes to the ordinary tables. To test the accuracy of the 30 years' limit, frequency tables have been compiled for 8 stations using all available data; the Madras observations cover a period of 85 years and Bombay 76, both of which show the 30 years' results to be quite satisfactory. The tables are grouped for the several divisions. At Cherrapunji, where there are two rainfall stations, the records extend over 30 years; these show a fall of 39 to 40 inches in the 24 hours, and 5 other falls between 30 and 35 inches, while there are in addition 25 falls between 20 and 30 inches in the 24 hours. There are more than ten other stations with a rainfall of upwards of 20 inches in the 24 hours. Rainfall frequencies at five stations in the south of the Bombay Presidency are given in an appendix; these are said to bear out Blanford's statement "that the greatest quantity of rain is yielded by falls not differing very much from those of average measurement." Reference is made to Part 7 of the same volume, which gives the monthly and annual rainfall amounts for all Indian stations to the end of 1920. (See NATURE, June 7, 1924, p. 836.)

MEASUREMENT OF RADIO FREQUENCY.—A paper (No. 489) of more than ordinary interest on the measurement of radio frequency by Grace Hazen and Frieda Kenyon has been published by the Bureau of Standards at Washington. A direct comparison is made between the accurately known frequency of a tuning fork and a high radio-frequency. Two intermediate radio frequency generating sets are employed and the adjustments are made by noticing the Lissajous figures produced in a cathode ray oscillograph. The tuning fork had a frequency of 1024·2 periods per second and was driven by a five-watt electron tube generating set. The intermediate generating sets each used a 250-watt electron tube. The oscillograph had a tube of the cold cathode type and required about 20,000 volts to operate it. The Lissajous figures were formed on the fluorescent screen by applying the two alternating magnetic fields at right angles to one another. The procedure adopted was to adjust the frequency of the first intermediate set to be a known multiple of the audio frequency. A range from 1·5 to 22 times the audio frequency was thus obtained. The second intermediate set was then adjusted to the first intermediate set in a similar way. Finally a point on the scale of the high frequency meter was found. The range of the wave meter standardised in this way extends from 3·5 to 5000 kilocycles per second. Photographs of the figures obtained and the apparatus used are given in the paper. The method seems to have been first used by L. M. Hull in 1919. The limitations of the accuracy attainable appear to be entirely in the audio frequency source used as the basis of the measurement and in calibrating and reading the wave meter.

THE ELECTRICAL CHARGE OF THE EARTH.—In a paper in the *Annalen der Physik* for October, Dr. C. Ramsauer directs attention to the fact that, though the surface density σ can be deduced from the potential gradient in the atmosphere by means of the formula $2\pi\sigma = -dV/dh$, a direct measurement requires a definite reference point, which can now be supplied by the state of an electrically neutral atom, containing an equal number of electrons and of protons. This is the state in the interior of every conductor, independently of the distribution of electricity on its surface; and an experiment is described in which an insulated plate A, parallel to and in the plane of the earth's surface, can be covered with a conducting cover B connected to the earth, so that A, which was originally part of the earth's surface, is now in the interior of the earth. A is connected to earth through a circuit containing a galvanometer and a key. The key is pressed down with B removed, the key is raised, B is placed over A, the key is pressed down and the charge on A discharged through the galvanometer. Another current can be produced when the cover is removed and A becomes charged again. It is possible to use an electrometer instead of a galvanometer, if the capacity of the condenser A – B is known. In this way, the excess of electrons for a definite area of the earth's surface is determined; the highest value observed was about 1×10^{10} electrons or 15×10^{-10} coulombs per square metre; on one occasion, during a light shower, the density fell from 14×10^{-10} coulombs per sq. m. to zero in a few minutes. Such variations are due to space charges in the atmosphere, and possibly to the charges of the heavenly bodies.

ZIRCONIUM AND HAFNIUM OXIDES.—G. Hevesy and V. Berglund have determined the densities of zirconium and hafnium oxides by the pyknometer method (J. Chem. Soc., November). X-ray examination showed that the latter oxide contained less than 0·5 per cent. of the former; both oxides were prepared from the normal sulphate and were carefully purified. The average densities obtained were (20°): ZrO_2 5·73, HfO_2 9·67; hence the percentage of hafnium oxide in a mixture of the two oxides is given by the formula $(d - 5{\cdot}73)/0{\cdot}0394$, where d is the density of the oxide mixture at 20°. This formula should only be used when both oxides are prepared by exactly the same method.

ERRATUM.—In a note on Mr. J. B. Kramer's paper entitled "An Electronic Battery," in the issue of December 13, p. 873, it was stated that the terminal connected to the carbon is negative; this is incorrect —the terminal connected to the zinc is negative, and that connected to the carbon positive.

Cloud Forms.

THE United States Weather Bureau at Washington has issued a publication [1] which would seem to be intended as a guide to cloud forms for meteorological observers. It consists of a short introduction, two diagrams of cloud height frequencies, a page devoted to definitions of cloud forms, taken from the International Cloud Atlas, and 32 photographs of different forms of cloud. The memoir gives in convenient form information which will be useful to meteorological observers, and if any criticism may be made, it is that a few of the photographs are not quite typical and some are not clear.

All modern cloud classification is based on the International Cloud Atlas. The classification adopted there is based on appearance. It is also recognised that form has been found to be largely dependent on height, and American observers argue that "it is therefore possible to gain information concerning the direction and velocity of the wind aloft by assigning the cloud to the height of most frequent occurrence, even though its exact height at the particular time is not known." This method has been widely used, but it has always seemed to the writer to be a procedure of very doubtful validity, especially when applied, as it frequently has been, to cirrus, for although, as we learn from the Weather Bureau Memoir, "the height of maximum frequency both summer and winter was between 8000 and 8400 metres," out of 227 measurements, yet there was a secondary maximum some 2000 metres higher. "Seven-tenths of all cirrus observed were found between 7600 and 11,200 metres," which is a fairly wide range, while cirrus has apparently been observed at Blue Hill, Mass., so low as 2400 metres and so high as 15,000 metres.

The method of assuming cloud heights and deducing the wind velocity at the cloud level by observing the drift is therefore liable to grave errors; the one theodolite method of observing pilot balloons has been much criticised on the same grounds, but on days when convection currents are not very active, it is not so liable to error as the cloud method. One can never be certain without cloud height measurements that one is dealing with a cloud at an average height.

The consideration of the maximum height of cirrus brings to mind the so-called "night shining clouds" observed in the last two decades of the nineteenth century, supposed to be associated with the eruption of Krakatoa. They had all the appearance of cirro cumulus, but their height was about 50 kilometres. The highest cirrus measured by A. W. Clayden was 27½ kilometres; there is thus a region of more than 20 kilometres in which clouds have never been observed, and then a level where they have been observed on rare occasions. Perhaps it is more than a coincidence that the height of the night shining clouds corresponds with the secondary or lower maximum of meteor disappearance as determined by Lindemann.

The two diagrams reproduced here (Figs. 1 and 2) give cloud height frequencies for the various forms of cloud, for summer and winter respectively, as observed at Blue Hill, Mass., based upon tabulations for each 400 metres, by H. H. Clayton. These diagrams are extremely interesting, and we wish that similar diagrams could be constructed for other parts of the globe; there must be a considerable body of information which might be made available, for there are to-day more methods than formerly of determining cloud heights. The diagrams show very clearly over what a wide range of height the various cloud forms

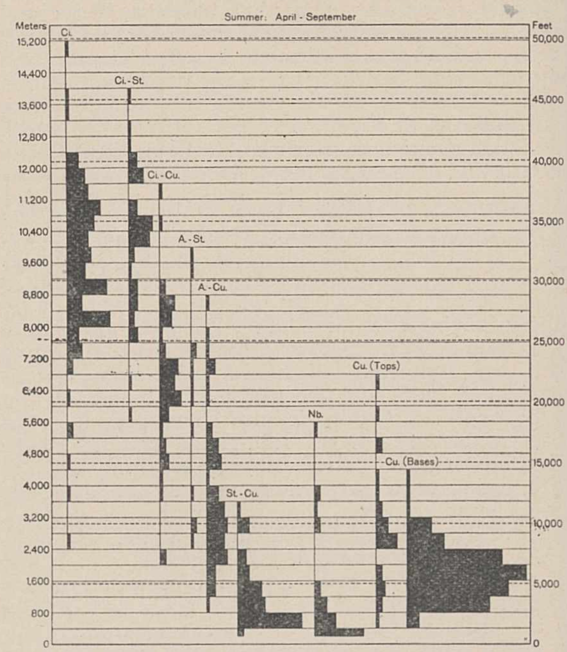


FIG. 1.—Cloud height frequencies, April to September, 1890–91 and 1896–97, Blue Hill, Mass., based upon tabulation for each 400 metres, by H. H. Clayton. Relative frequency is indicated by width of figure. From "Cloud Forms."

extend; alto cumulus overlaps cirro cumulus, and strato cumulus overlaps alto cumulus, and one is tempted to wonder whether there is any essential difference between the three forms, since neither in

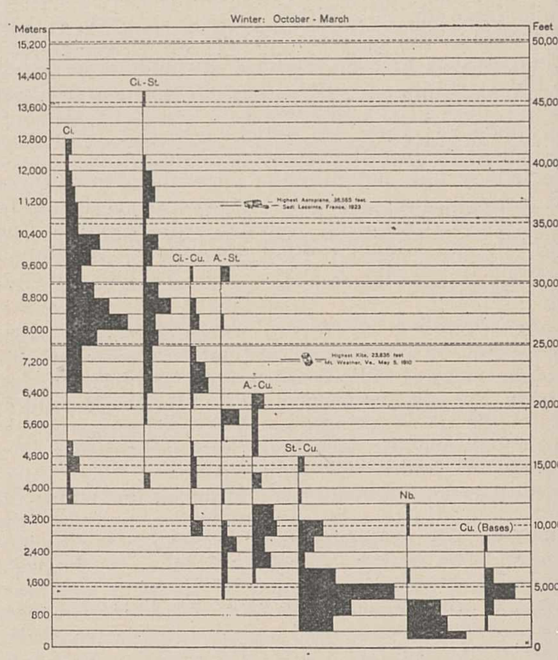


FIG. 2.—Cloud height frequencies, October to March, 1890–91 and 1896–97, Blue Hill, Mass., based upon tabulation for each 400 metres, by H. H. Clayton. Relative frequency is indicated by width of figure. From "Cloud Forms."

[1] U.S. Department of Agriculture, Weather Bureau. "Cloud Forms according to the International System of Classification." Prepared by the Weather Bureau Cloud Committee: Benjamin C. Kadel, Harry C. Frankenfield, and Franklin G. Tingley. Pp. 22. (Washington: Government Printing Office, n.d.) n.p.

appearance nor in height is there any line of demarcation. This is indeed recognised, for in one of the photographs, illustrating the Weather Bureau publication, of strato cumulus or alto cumulus, a note is added that "these same clouds would be called strato cumulus by an observer nearer to them and alto cumulus by an observer farther from them (as at sea level)." The heights given for nimbus are curious; the maximum frequency is quite low, 400 metres for both summer and winter, but there are occasional observations at higher levels, one in summer so high as 5000 metres.

The photographs which constitute the bulk of the Weather Bureau Memoir are interesting; and some, such as the undulated alto stratus seen from above at Mount Wilson (Plate 11), and the same form of cloud seen from below at Washington (Plate 13), are very beautiful. There is one remark to which exception might be taken; it occurs as a note under a fine photograph, by Sir David Wilson-Barker, of small alto cumulus, and runs: "Even if there are no shadows the presence of coronas or iridescent colours near the sun or moon distinguish such small alto cumulus from cirro cumulus." In the present writer's experience, iridescence and coronæ are quite common in clouds which would be classified as cirro cumulus.

The Locust Problem and its International Solution.[1]

By Dr. A. D. IMMS.

IT is a matter of common knowledge that the damage occasioned by locust invasions is frequently extremely serious. Thus, in the year 1874, the destruction brought about by these insects in the Rocky Mountains amounted to approximately forty million dollars. In 1908 an estimated damage of one million sterling was caused by locusts to crops in the Transvaal, while the cotton crop in Egypt has often suffered severely. The intensity of an attack, and some idea of the damage done, may be gauged from the number of locusts often found within a comparatively small area. For example, in Southern France in 1920, between twelve and thirty million locusts were destroyed daily, while twenty tons of eggs were collected in a single month in the Argentine in March 1915. Since the year 1914 the countries affected by locusts include the greater part of Africa, certain parts of Spain, France, Italy, Asia Minor, Turkestan, etc. The regions more especially affected lie between 20° and 40° latitude north and 15° and 45° latitude south, the equator being comparatively immune. In order to deal with these outbreaks some international organisation appears necessary, and it is to be hoped that the League of Nations will lend its authority to assist in arriving at a concerted plan of action. The need for international action is obvious when it is remembered that locust swarms can travel 18 to 300 miles in a single day, thus easily migrating from one country into another.

Very large amounts of money are spent yearly by some countries on preventive measures. The danger to public health caused by locust invasion is far smaller than formerly, and the last severe famine due to locust devastation was in 1866. In that year about 200,000 natives perished in North Africa. The obstruction and poisoning of wells and other water supplies, however, may still entail very serious consequences.

No really adequate biological studies of locusts are available, and knowledge has scarcely yet progressed beyond empirical methods. Much that has been written on the migration and breeding of these insects is sufficiently untrustworthy to demand renewed investigation. Important work, however, has been done by Uvarov, J. C. Faure and Hernandez. Among the results achieved, the most important is the demonstration that certain species of locusts have two distinct phases in their development: the migrating or gregarious phase and the solitary or individual phase. Uvarov has devoted attention to the problem of migrations. These are not the result, as commonly supposed, of the necessity of finding fresh food. Locust swarms frequently leave fertile lands for others which are far less so. The factors governing these migrations need renewed study, but they appear to be governed by variations of temperature rather than by the availability of vegetation. Important changes in the physiology of the individual locusts have also been observed during migration. Until sufficient biological data are available, emergency action will have to be continued in order to restrict migration and the resulting damage to crops. It is to be hoped, however, that the problem will be solved if the States interested will provide for the biological investigation of locusts instead of being satisfied with occasional emergency measures.

Methods of control are very varied, and it may be added that the utilisation of natural agents has been insufficiently explored. The study of the insects' parasites demands further attention, and we are still not in a position to say whether important results may or may not be expected from this line of work. Attempts at propagating bacterial or other diseases have not yet been successful. Mechanical methods by means of artificial barriers are numerous, and these provide the means for arresting and destroying locusts in bulk but they are not by any means adequate. Physical methods—the use of fire—have been applied in various ways. The modern French method of using the army flame-projector has been employed with great success in Algeria. A single charge of 12 litres of crude oil is sufficient to destroy all locusts gathered on a surface of 500 square metres. Among chemical methods, the use of poison gas has not proved successful in experiments. Among insecticides, arsenate of soda appears to be the most satisfactory compound, and in Italy other methods of destruction have now been abandoned.

International conventions for combating these insects first came into being in South America and South Africa. A further important step was taken at the Rome conference of 1920, when thirty-five countries signed a convention naming the International Agricultural Institute as the headquarters of an International Locust Information Bureau. Unfortunately, it does not seem that much progress has been made, and the International Institute has not been in a position to publish reports from the Governments concerned except a few from Algeria, Bulgaria, French West Africa, and Hungary. Good work, however, has been done by North African countries, which have concluded a special agreement among themselves. It is to be hoped that effect will be given to the resolutions of the 1920 Convention and that the need of financing skilled biological study of locusts will be recognised. M. Vayssière outlines a scheme of the international organisation he proposes and suggests the League of Nations as being best able to give that assistance necessary to secure effective international co-operation of the kind required.

[1] "Le problème acridien et sa solution internationale." By Paul Vayssière, in *Matériaux pour l'étude des calamités*, No. 2, 1924, pp. 122-158. (Publiés par les soins de la Société de Géographie de Genève.)

Fields of Progress in Chemistry.

THE American Chemical Society has started a new venture in the form of a quarterly issue of *Chemical Reviews*. The first issue contains four articles: on "Atomic Weights and Isotopes" (40 pp.), by Prof. T. W. Richards; on "The Constitution of Polysaccharides" (31 pp.), by Principal J. C. Irvine; on "The Theory of Membrane Equilibria" (18 pp.), by Prof. F. G. Donnan, and on "Organic Radicals" (51 pp.), by Prof. M. Gomberg. These four articles were prepared in connexion with the dedication of the Sterling Chemical Laboratory, and are now published as part of the first volume of *Chemical Reviews* by permission of Yale University.

Although prepared for another purpose, the articles may perhaps be regarded as a type to which later *ad hoc* contributions will tend to conform, and may therefore be used as the basis for an answer to the obvious question as to whether a new publication of this kind is likely to be of permanent usefulness. In our opinion, the answer is in the affirmative. Twenty years ago, in 1904, the Chemical Society of London began a series of Annual Reports on the Progress of Chemistry in order "to present an epitome of the principal steps in advance which have been accomplished in the preceding year"; and more recently the Society of Chemical Industry has supplemented this work by a series of Annual Reports on the Progress of Applied Chemistry. These annual reports have established themselves as an indispensable supplement and guide to the contents of the Abstracts of the preceding year. Their most obvious limitations are found in two directions. The first is a tendency to "scrappiness," which must always result from the cutting up of a continuous series of experiments into yearly "progress reports." The second is the risk that the personal interests of the reporter in a particular branch of chemistry may lead to the over-emphasis of progress in certain directions, and the neglect of important work in others.

These limitations have been minimised by changing the reporters after a period of perhaps three years, and by encouraging them to trace in some detail the earlier stages of researches in which important progress has been made during the year; but it is clear that the new series of *Chemical Reviews* will have the great advantages that the articles will deal with a small number only of live topics and that the summaries will be authoritative statements by the worker himself, instead of by a reporter. For the general student, who wishes to secure an introduction to current literature, it may very well prove of even greater value than the Annual Reports; and, judging by the earliest samples, they have the merit of being eminently readable, so that it is a pleasure rather than a duty to study them. On these grounds the new publication may be heartily welcomed, as providing in a systematic form the type of publicity that has hitherto only been given spasmodically in lectures and presidential addresses. The price of the publication is five dollars for each annual volume, or four dollars to members of certain cognate societies; it is also proposed, if there is sufficient demand, to issue reprints of the individual articles, so that a whole class can be supplied with copies.

The International Critical Tables.

AT the meeting of the International Union of Pure and Applied Chemistry held in London in 1919, the American delegates submitted a proposal for the international compilation of critically prepared tables of the physical properties of chemical substances and technological materials. The proposal was approved by the Union, and the American National Research Council at Washington has since undertaken the financial and editorial responsibility for the undertaking. A Board of Trustees has undertaken to raise the sum of 200,000 dollars or such part thereof as may be necessary. The editorial responsibility is invested in a Board of Editors, the editor-in-chief being Dr. E. W. Washburn, formerly professor of physical chemistry at the University of Illinois.

To ensure the international character of the Tables, corresponding editors have been appointed in the principal countries of the world. It may be added that the Tables are in no sense a commercial undertaking and the members of the boards of trustees and editors and the corresponding editors serve in an honorary capacity.

The work of critically examining the data and of compiling the various tables is being carried out by well-known chemists, physicists, engineers, etc., some three hundred in number, who have been chosen for this purpose in the various countries of the world, largely on the basis of recommendations from the corresponding editors and their advisory committees. These authorities are not being expected to assume the responsibility of searching the literature, a task which is being carried out in the main by the editorial staff at Washington, but rather to assemble, to examine critically, and to select the best value for each constant, indicating at the same time the probable uncertainty. Each portion of the Tables will be published over the name of the co-operating authority who has assumed responsibility for it, and the size of each assignment has been restricted so that the work may be carried out within a reasonable time and without becoming too great a burden for any individual (or co-operating group of individuals) to bear.

The main language employed in the Tables will be English, but the introduction, table of contents, definitions, general explanatory text, and a very complete index will be in English, French, German, and Italian.

The Tables will contain all available information of value concerning the physical properties and numerical characteristics of (*a*) pure substances, (*b*) mixtures of definite composition, (*c*) the more important classes of industrial materials, (*d*) many natural materials and products, and (*e*) selected data for certain bodies or systems, such as the earth and its main physical subdivisions, the solar and stellar systems, and certain biological organisms, including man.

The scope of the Tables is so immense, and of such an unprecedentedly comprehensive character, that special attention has had to be given to the arrangement so as to enable the Tables to be used with facility and dispatch. For pure chemical substances the data will be assembled in tables of properties, but a certain amount of latitude and duplication will be permitted in some instances, and tables of materials will be employed where it proves to be more convenient. In some cases no definite value of a constant can be put down, but only upper and lower limits. In other cases a graph may be the best means of indicating the variation of the particular property in question.

The importance of securing uniformity in the case of fundamental constants, conversion factors, etc., has not been lost sight of, nor the importance of associating, where possible, with the data for a particular specimen or material, a statement of the exact experimental conditions, life history, etc.

The Tables will be issued in a series of volumes comprising a total of about 2500 pages (10 in. × 7 in.), publication extending over about a year and a half. The progress made has been such that the first volume is now in the press and may be expected during the early months of 1925. The published price of the Tables will be from 60 to 75 dollars for the set, but the trustees are reserving the privilege of purchasing from the publishers at the rate of 35 dollars per set whatever number of sets may be required to fill all advance subscriptions received by the National Research Council of America up to a definite fixed date, probably April 1 or May 1, 1925. This price represents only the cost of printing, but the trustees and the National Research Council are anxious that all scientific men and women shall be given the opportunity of taking advantage of the lower rate. Accordingly, arrangements are being made so that (1) members of a recognised scientific, technical or engineering society, or (2) universities, research laboratories, libraries, government departments or the like, will shortly be given preferential facilities for purchasing sets at the lower figure before the expiration of the above-mentioned date. The National Research Council will deal with such applications, but all orders placed in the ordinary way through the trade will be handled by the publishers at the higher figure.

The Advisory Committee for the British Empire (excluding British North America) consists of Dr. G. W. C. Kaye (corresponding editor), Sir Robert Robertson, Dr. W. Rosenhain, Prof. A. W. Porter, Dr. T. E. Stanton, Mr. J. E. Sears (jun.), Mr. A. C. G. Egerton, and Mr. W. F. Higgins as secretary. Dr. Rosenhain is also acting as special editor for metals and alloys. It is requested that any correspondence from the British Isles with reference to the Tables should be addressed to Dr. Kaye, The National Physical Laboratory, Teddington, Middlesex.

University and Educational Intelligence.

BELFAST.—Dr. J. A. Milroy has been appointed J. C. White professor of bio-chemistry in the Queen's University. Dr. Milroy came to Belfast in 1902 as demonstrator in physiology, and on the foundation of the University in 1909 he was appointed lecturer in bio-chemistry. The title of reader in bio-chemistry was conferred on him in 1922. He is the author of numerous articles in the *Journal of Physiology* and other scientific papers.

Dr. V. D. Allison has been appointed J. C. White lecturer in bacteriology in the University. Dr. Allison is a graduate of the University, and since 1920 has continued his studies as research student in the Institute of Pathology as a Beit Memorial Research Fellow, working under Sir Almroth Wright and Prof. A. Fleming.

BIRMINGHAM.—Applications are invited for the professorship of philosophy in succession to Prof. Moberly. Applications (fifteen copies of each), copies of three testimonials, etc., must reach the Secretary of the University by February 2 at latest.

LONDON.—The following doctorates have been conferred :—*D.Sc.* (*Botany*) : Miss K. B. Blackburn (Bedford College), for a thesis entitled "The Cytological Aspects of the Determination of Sex in the Dioecious Forms of Lychnis" ; *D.Sc.* (*Chemistry*) : Mr. Harold Hunter (East London College and Battersea Polytechnic), for a thesis entitled "The Chemical Significance of Optical Dispersion" ; *D.Sc.* (*Physics*) : Mr. A. H. Davis, for a thesis entitled "Natural and Forced Convection of Heat in Gases and Liquids," and other papers ; Mr. J. H. Shaxby, for a thesis entitled "Papers on Molecular Physics," and other papers ; Mr. J. E. P. Wagstaff, for a thesis entitled "The Measurement of Short Time Intervals and its Application to (*a*) the Determination of the Velocity of Detonation of Explosives, (*b*) the Duration of Impacts of Bars mainly with rounded Ends, in elucidation of the Elastic Theory," and other papers.

MANCHESTER.—Applications are invited for a lectureship in anatomy. The latest date for applications is February 11. They should be sent to the Internal Registrar, from whom particulars may be obtained.

OXFORD.—Applications are invited from persons possessing a thorough knowledge of entomology in its application to forestry and with experience of tropical conditions for the post of entomologist at the Imperial Forestry Institute. Applications, stating age, qualifications, and salary required, and furnishing references and copies of testimonials, with a list, and if possible copies, of published writings, should be submitted not later than April 15, to the Secretary of the Institute.

THE official report of the Indian Universities Conference held at Simla last May (Calcutta, Govt. of India Central Publication Branch, pp. 79. 8*d.*) gives in full the Viceroy's inaugural address, two addresses by the Minister of Education, Health and Lands, and the 49 resolutions passed by the Conference, and brief summaries of the discussions. The most important outcome of the Conference is the project for an inter-university board. Steps have already been taken to bring this into being, a provisional committee having been appointed immediately after the close of the Conference to make further detailed suggestions for the consideration of the universities. This it has done, and it is proposed to hold the first meeting of the board in Calcutta, if possible in February next. The Conference has, moreover, recommended to the Government of India that a central advisory board for scientific research be constituted in India, comprising the heads of scientific departments of the Government and a representative of science nominated by each of the Indian universities and by the Indian Institute of Science, with power to co-opt representatives of other recognised institutes of science not affiliated to any university. It is intended that this Board should, among other things, co-ordinate scientific publications in India, utilising or combining existing organs and developing them on an all-India basis and recommending to Government cases where financial assistance would be desirable. It would consider whether the publications of the Indian Museum and the Botanical Survey of India, the Memoirs of the Geological Survey of India, and the *Agricultural Journal of India*, now issued by Government, should not have on their editorial boards expert representatives of the various universities, and whether the scope of these journals should not be enlarged. It would also advise the Government from time to time generally with regard to the promotion of scientific research in India. Another resolution demands the remission of customs duty on scientific apparatus and chemicals imported for the use of universities and other approved educational institutions.

Early Science at the Royal Society.

January 3, 1662/3. The president reported a letter in favour of the society to the duke of Ormonde, lord lieutenant of Ireland.—" I am desired by the Royal Society in their names to entreat your grace's favour and countenance in the effectual settlement of the fractions of adventures, arrears, lands, &c., which by the act for the better execution of his majesty's gracious declaration were vested in his majesty, in trust for, and the better to enable his majesty to grant the same to them, so as his majesty being their founder might also be their chief benefactor" . . . [signed Brouncker, P.R.S.].—Sir William Petty who was then in Ireland, was desired to make a calculation of these fractions of adventures &c., which he accordingly did, but did not send the society the result of it, in regard that interest was past before by patent acts unto some others, as he mentions to Sir Robert Southwell, when the latter desired him, in the name of several of the most eminent members of the society, to send over to them his calculations.

January 4, 1664/5. Mr. Francis Willughby being come home from his travels [mostly in Spain] and present, was desired to communicate his philosophical observations. He produced a printed cut representing Saturn and Jupiter, and what Campani had lately observed in them by means of his new glasses, wrought by a turn-tool without a mold.

1666/7. Mr. Oldenburg read an extract of Mons. Auzout's letter to him from Paris, mentioning a new method esteemed by him better than any hitherto practised, of taking the diameters of the planets to seconds, and of knowing the parallax of the moon by means of her diameter. Dr. Wren and Mr. Hooke having related to the society several ways, which they had known long before of taking the diameters of the planets to seconds, were desired briefly to describe them, that so it might be signified to the Parisian philosophers, that it was a thing not at all new among the English.

January 6, 1663/4. Mr. Boyle remarked that swallows frozen up in ice, upon the thawing away of the ice had been found alive, and flying about; and that a minister had sent a certificate of this to the king from Dantzic.—Sir Robert Moray related that he had been informed by his highness the Duke of York, that there were certain little springs at Croyden, which would run together, and make a stream for a certain space, and then slide under the ground, and afterwards break out again. Dr. Wilkins having acquaintance at Croyden, was desired to make a particular inquiry after this fact.

January 7, 1662/3. Mr. Bruce brought in an account of windmills in Holland, which was ordered to be registered. [We may recall here the reference that was made in NATURE, of Sept. 13, to the acquisition by the Franklin Institute in 1922, of a collection of books and pamphlets on windmills, inclusive of treatises on the subject in German and Dutch, 17th and 18th centuries.]

January 8, 1661/2. Sir Robert Moray communicated letters, in French, from Mons. Frenicle to Mons. Huygens, concerning the hypothesis of Saturn.—Mr. Rooke read a paper of inquiries to be made in the East-India captain's voyage to Bantam.—It was ordered that all the papers of inquiries for foreign parts be written out into one paper.

1672/3. There was produced to the society a discourse of Dr. Grew, concerning his whole design with respect to vegetables, and the means of effecting it. Part of this discourse was read, to the great satisfaction of the Society who urged the publication of it.

Societies and Academies.

LONDON.

Royal Anthropological Institute, December 9.—H. **Balfour**: The origin of the art of stencilling in the Fiji Islands. The use of stencils in the Fiji Islands, for decorating bark-cloth, does not appear to have been introduced into the group from the outside, and it was suggested that the stencil designs, which are cut in leaves almost invariably, may very probably have been suggested by leaves which have been tunnelled by insect larvæ while still in the tightly rolled up state of the budding leaf. The leaves, when they unroll in the course of their development, exhibit transverse alignments of regular perforations, which bear a striking resemblance to some of the simpler Fijian stencil designs.

PARIS.

Academy of Sciences, November 24.—L. **Lecornu**: The tetrahedral system. Lowthian Bell, in 1875, regarded the earth as possessing a symmetry analogous with that of a regular tetrahedron. This question has been examined by several geologists: the author submits it to a mathematical analysis, applying the theory given in a recent note (*Comptes rendus*, t. 179, 1924, p. 853) on the deformation of a spherical envelope.—J. and Mlle. M. **Bordet**: The bacteriolytic power of colostrum and milk. Colostrum exerts a powerful bacteriolytic action upon organisms commonly present in the atmosphere. This confirms the work of Jensen (1905) and of T. Smith and Little (1922).—W. **Kilian**: The fluvio-glacial deposits of the southern bank of the lake of Geneva and their hydrological regime (Evian, Amphion, Thonon).—Jules **Andrade**: A curious theorem of metrology and its applications to chronometry.—P. J. **Myrberg**: A generalisation of the linear equations of finite differences.—E. F. **Collingwood**: The exceptional values of integral functions of finite order.—Nikola **Obrechkoff**: The convergence of trigonometrical series.—Paul **Mentré**: The non-special complexes with multiple inflectional focus.—D. **Riabouchinsky**: Some considerations on the plane rotational movements of a liquid.—P. **Idrac**: Theoretical study of the flight of the albatross in a wind increasing with the altitude.—Charles **Nordmann** and C. **Le Morvan**: Variable stars with continuous variation and Ritz's hypothesis. de Sitter has adduced observations on double stars as evidence in favour of the constancy of the velocity of light. La Rosa has criticised these views and concludes that observation of these stars proves nothing for or against the hypothesis of a constant velocity of light. The authors have shown that the amplitude of the light variation of variable stars with continuous variation is not the same in different regions of the spectrum. This experimental fact the authors consider invalidates the extension of the ballistic hypothesis of Ritz, as given by La Rosa.—F. **Baldet**: Observations of the planet Mars with the 83 cm. telescope of the Meudon Observatory. Reproductions of six drawings of the planet are given, taken between September 5 and 28. All the observations detailed confirm those already published by Antoniadi. No trace has been found of the geometrical network of filiform " canals."—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the second quarter of 1924. Observations were possible on 83 days during the quarter. The results are summarised in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Rafael **de Buen**: Some observations on the course of the currents in the Straits of Gibraltar.—

P. **Gaubert**: The circular polarisation of the light reflected by insects. Detailed examination shows that the insect behaves as though the cuticle which surrounds it had been cut out of a single sheet of tissue capable of polarising light circularly. Two hypotheses are examined, in which the presence of liquid crystals is assumed. Cholesterol melts at 147° C., and as the polarisation phenomena do not completely disappear below 300° C., the presence of this substance does not afford an explanation.—L. **Décombe**: Electrified spherical films. The direct calculation of the constant of gravitation as a function of the constants of Avogadro, Faraday, Rydberg, and Planck.—Ch. **Féry**: A lead accumulator incapable of being sulphated. The fundamental equation governing the working of the ordinary secondary battery is assumed to be

$$2Pb + H_2SO_4 + Pb_2O_5 \rightleftarrows Pb_2SO_4 + 2PbO_2 + H_2O.$$

According to this view, lead sulphate, $PbSO_4$, is not formed during a normal discharge. The spontaneous discharge of an accumulator on standing is regarded as due to the combined action of oxygen and the electrolyte on the negative plate

$$2Pb + H_2SO_4 + O = Pb_2SO_4 + H_2O,$$

with a secondary reaction

$$Pb_2SO_4 + H_2SO_4 + O = 2PbSO_4 + H_2O.$$

To avoid the last reaction it should be sufficient to prevent access of oxygen to the negative plate. A description is given of a new form of accumulator designed to fulfil this condition. This battery retained 33 per cent. of its charge after standing 26 months, corresponding with a discharge of 4 per cent. per month. If discharged, and allowed to stand two years, it could be recharged normally.—Victor **Henri** and C. **Teves**: The absorption spectrum of sulphur vapour as depending on the constitution of the molecules. The molecules S_8 and S_6 present a structureless continuous absorption spectrum. The S_2 molecules possess an absorption spectrum formed of a very large number of bands, the structure of which is analysed in detail (*v.* also NATURE, December 20, p. 894).—M. **Bourgeaud** and A. **Dondelinger**: Researches on the affinity constant of some organic bases.—D. **Yovanovitch** and J. **d'Espine**: The magnetic spectrum of the high velocity β-rays of mesothorium 2. Two of the lines have velocities 0·998 and 0·986, compared with the velocity of light taken as unity.—A. **Vila**: The reduction of sulphuric acid to hydrogen sulphide. The vapours of sulphuric acid mixed with an excess of hydrogen and passed over silica at a red heat (700° C. to 900° C.) give almost theoretical yields of hydrogen sulphide.—L. J. **Simon** and V. **Hasenfratz**: The lactone of *l*-arabonic acid and some of its derivatives.—Ch. **Courtot** and A. **Dondelinger**: The α-halogen derivatives of indane.—C. **Kohn-Abrest**: The gases in fresh, putrefied, and frozen blood. Application of the method described in a previous paper to the determination of carbon dioxide, oxygen, nitrogen, and sulphuretted hydrogen in blood. It is shown that freezing blood not only arrests putrefaction, but also removes some hydrogen sulphide if this has been already produced by putrefaction.—Y. **Milon**: The fauna and the age of the Waulsortian limestones of Saint-Pierre-la-Cour.—G. **Mouret**: The true prolongation, at Bourganeuf (Creuse), of the Argentat fault and the nature of the supposed schists and gneiss of that region.—Louis **Barrabé** and Pierre **Viennot**: The discovery of an oil-bearing layer at Gabian (Hérault). This boring has been carried to a depth of 107 metres, and the present hourly yield of crude oil is between 500 and 600 litres. The oil has a density of 0·846 at 15° C., contains 10 per cent. of wax and only traces of asphalte.—Gabriel **Guilbert**: The case of destruction of a cyclone.—Ph. **Schereschewsky** and Ph. **Wehrlé**: Polar pseudo-fronts.—H. **Colin**: The formation, distribution, and circulation of inulin in the stem of the Jerusalem artichoke.—J. **Chaze**: Attempts at pure cultures of a Saprolegnia.—Marc **Bridel**: The presence of very large quantities of free maltose in the fresh tubercles of *Umbilicus pendulinus*. These tubercles contain large quantities of maltose as a food reserve, and it has been possible to obtain nearly 4 per cent. in the crystalline state. This is the first time that maltose has been directly extracted in the crystalline state from plants.—R. **Cerignelli**: Indol in the flowers of Spanish jessamine (*Jasminum grandiflorum*). Indol is a normal constituent of the flowers of this plant.—J. **Chaussin**: Study of the soluble medium and the insoluble tissues in the course of the development of wheat: the influence of a complete mineral manure.—Lucien **Daniel**: Heredity in grafted plants.—M. **Munerati**: Contribution to the study of the appearance of sex in dioic plants.—L. **Mercier**: The action of naphthalene vapour on *Calliphora erythrocephala*. Study of the microscopic lesions presented by the individuals showing malformation.—L. **Leger**: A new crayfish in French waters.—P. **de Beauchamp**: The appearance of variations under experimental conditions in rotifers of the genus Brachionus.—R. **Herpin**: The swarming of *Perinereis Marionii*. The evolutive cycle of *Platynereis Dumerilii*.—Ph. **Joyet-Lavergne**: The cytoplasmic characters of sexuality in the Gregarinæ.—W. **Vernadsky**: The representation of the chemical composition of living matter.—Mlle. Eliane **Le Breton** and Charles **Kayser**: The metabolism of the purins in diabetes.—Mme. L. **Randoin** and H. **Simonnet**: Growth and maintenance of the rat submitted to an artificial diet deprived both of factor B and glucides.—C. **Dawydoof**: The return of *Lineus lacteus* to an embryonic state under the influence of starvation.—C. **Lebailly**: Flies play no part in the dissemination of aphthous fever.

VIENNA.

Academy of Sciences, November 13.—F. M. **Exner**: The pressure of sand-hills. Attempts have been made to measure the pressure on a plane undersurface of sand masses thrown up with maximum slopes. The pressure values in the middle of the base were about those of water columns of the same height, although the density of sand is 1·5. Towards the edges the pressure decreases more slowly than would correspond to the height of the sand. This is because the side columns, in consequence of friction, bear part of the weight of the central columns. Hyperbolas drawn between the sloping surfaces as asymptotes correspond to this pressure distribution. The idea can be applied to determine the form of the compensation defect masses below sea-level in the theory of isostasy.—F. **Pollak**: The kinetics of dissolved gases. I. The evaporation of carbon dioxide from watery solution into a stream of bubbles of an indifferent gas.—M. **Kohn** and G. **Löff**: VIII. Communication on bromo-phenols. Bromo- and bromo-nitro-resorcin.—M. **Kohn** and G. **Löff**: On styphnic-acid-mono-methyl-ether and a new trinitro-guaiacol.—M. **Kohn** and R. **Lakner**: On the action of magnesium-phenyl-bromide on bromo-ethyl-phthalamide.—A. **Kieslinger**: Report on geological and petrographic researches in the Southern Kor Alps on the boundary of Styria and Carinthia. These include (*a*) old crystalline, Teigitsch series, etc.; (*b*) diaphthorite zone; (*c*) Mahrenberger series; (*d*) Tertiary covering.—J. **Kaesz**: Solution of the Deli-problem by compasses and ruler.—H. **Priesner**: New Thysanoptera.

Official Publications Received.

Ceylon Journal of Science. Section A, Botany. Annals of the Royal Botanic Gardens, Peradeniya. Vol. 9, Part 2, November 22. Pp. 119-241. (Peradeniya: Department of Agriculture; London: Dulau and Co. Ltd.) 3 rupees.

Spolia Zeylanica. Issued from the Colombo Museum, Ceylon. Edited by Dr. Joseph Pearson. Vol. 12, Parts 47 and 48. Pp. 335-408. (Colombo.)

Report of the Botanical Survey of India for 1923-24. Pp. 13. (Calcutta: Government Printing Office.)

Appendix No. 2 to the Annual Report of the Chief of the Bureau of Navigation, 1924. Annual Report of the Naval Observatory for the Fiscal Year 1924. Pp. 25. (Washington: Government Printing Office.)

The Indian Forest Records. Vol. 10, Part 5: Analysis of the Tanning Properties of certain Burma *Lagerstroemias*. By E. Pasupati; reported by J. A. Pilgrim. Pp. 28. 7 annas. Vol. 10, Part 8: The Constituents of some Indian Essential Oils. Part 13: The Essential Oil from a new Species of *Andropogon* occurring in the Etawah District, U.P. By John Lionel Simonsen. Pp. 13. 3 annas. Vol. 10, Part 10: The Mangroves of South Tenasserim; being an Account of an Investigation of various Products of the Littoral Forests of Southern Burma. By J. A. Pilgrim. Pp. iii+73. 15 annas. (Delhi: Government Central Press.)

Commercial Intelligence Department, India. Agricultural Statistics, 1921-22. Vol. 2: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, and Land Revenue Assessment, in certain Indian States. Pp. ii+v+83. (Calcutta: Government of India Central Publication Branch.) 15 annas; 1s. 6d.

Transactions of the Royal Scottish Arboricultural Society. Vol. 38, Part 2, October. Pp. 69-155+27-36. (Edinburgh.) 3s.

Bulletin of the American Museum of Natural History. Vol. 50, Art. 6: Insect Sounds. By Frank E. Lutz. Pp. 333-372. (New York.)

The Physical Society of London. Proceedings. Vol. 37, Part 1, December 15. Pp. 74. (London: Fleetway Press, Ltd.) 6s. net.

Leeds University. Twentieth Report, 1923-24. Pp. 164. (Leeds.)

Diary of Societies.

SATURDAY, JANUARY 3.

GEOGRAPHICAL ASSOCIATION (Annual Meeting) (at London School of Economics), at 9.30 A.M.—S. W. Rider and Capt. T. K. M. Booth: Discussion on School Geography.—Miss A. Hicks and others: Discussion on The Beginnings of Geography.—J. A. Mortlock, Miss J. A. Hardy, and others: Discussion on The Teaching of Climate.—Miss L. C. Read, C. C. Carter, and others: Discussion on Home Geography.—Mr. Cattell-Jones, Rev. J. I. Miller, and others: Discussion on School Geography Clubs and Journeys.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (IV.). The Habits of the Dragonfly.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—Dr. W. Martin: Gilbert White as Antiquary.

MONDAY, JANUARY 5.

MATHEMATICAL ASSOCIATION (at London Day Training College), at 10.20 A.M.—Prof. J. E. A. Steggall: The Neglect of Arithmetic in Schools.—A. Buxton: An Application of the Bessel Functions to a Problem in Optical Resolution. Discussion on Tangency and Limits in Geometry.

EUGENICS EDUCATION SOCIETY (at University College), at 11.—National League of Health, Maternity, and Child Welfare.—Dr. J. A. Hadfield: Mental Health of the School Child.

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—Brig.-Gen. Sir Wyndham Deedes: Great Britain and the Palestine Mandate.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at University College), at 6.—Dr. P. B. Ballard, T. Raymont, and others: Discussion on the recent Report to the Board of Education on Psychological Tests of Educative Capacity.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. G. Dawes Hicks: The Dynamic Aspect of Nature.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—W. Irwin: An Early Chapter in the Benzol Industry.

INSTITUTION OF THE RUBBER INDUSTRY (London Section) (at Engineers' Club), at 8.—A. Healey: Mechanical Structure of Rubber.

SCIENCE MASTERS' ASSOCIATION (Annual Meeting) (at University of Leeds), at 8.45.—Sir Berkeley Moynihan, Bart.: Presidential Address.

TUESDAY, JANUARY 6.

SCIENCE MASTERS' ASSOCIATION (Annual Meeting) (at University of Leeds), at 10 A.M.—Prof. J. H. Priestly: Peat and the Plants that Grow upon it—A Yorkshire Problem.—C. B. Fawcett: The Distribution of Population.—At 12, Prof. R. Whiddington: The Trend of Modern Physics.—Prof R. W. Whytlaw-Gray: The Inert Gases.—At 5.30, Prof. W. Garstang: The Songs of the Birds.

MATHEMATICAL ASSOCIATION (at London Day Training College), at 2.30.—Prof. G. H. Hardy: What is Geometry? (Presidential Address).—Dr. H. B. Heywood: The Reform of University Mathematics.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (V.). The Habits of the Water-Beetle.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at Manchester), at 3.30.—Dr. J. E. Myers and F. Fairbrother: A Few Chemical Curiosities.

ASSOCIATION OF UNIVERSITY WOMEN TEACHERS (at University College) at 5.—Prof. F. Soddy: The Economics of Life.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—C. H. Wright: Some Considerations in connexion with the Measurement of Liquid Fuel Storage and Liquid Depths.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—T. H. Gant: Cobalt: Its Production and Some of its Uses.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Section) (at Broadgate Café, Coventry), at 7.15.

WEST YORKSHIRE METALLURGICAL SOCIETY (at George Hotel, Huddersfield), at 7.30.—The Value of some Workshop and Laboratory Tests.

RÖNTGEN SOCIETY (at British Institute of Radiology). at 8.15.—Dr. N. S. Finzi: Some Developments in Deep-Radio Therapy.

WEDNESDAY, JANUARY 7.

SCIENCE MASTERS' ASSOCIATION (Annual Meeting) (at University of Leeds), at 10 A.M.—Prof. A. Smithells and others: Discussion on the Connexion between Science Teaching in Schools and Universities.

ROYAL SOCIETY OF ARTS (Dr. Mann Juvenile Lectures (1)), at 3.—Lt.-Col. G. M. Richardson: Dogs in War.

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

GEOLOGICAL SOCIETY OF LONDON, at 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Prof. E. Mallett and A. D. Blumlein: A New Method of High-Frequency Resistance Measurement.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Engineers' Club), at 7.—O. Stott: Water Gauge.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—Dr. A. Russell: Presidential Inaugural Address.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

THURSDAY, JANUARY 8.

LEAGUE OF NATIONS UNION (at University College), at 11.30.—Prof. H. G. Fleure: Geography and the League of Nations.

CHILD-STUDY SOCIETY (at University College), at 3.—Prof. E. W. MacBride: The Evidence for the Existence of Environmental Influence on the Course of Heredity.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (VI.). The Habits of Insects and the Work of Man.

LINNEAN SOCIETY OF LONDON, at 5.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. W. Taylor: Three-Wire Direct-Current Distribution Networks: Some Comparisons in Cost and Operation.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—F. J. Lawson: Telephone Cable Practice.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7.45.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—J. P. Maxwell: Osteomalacea in China.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch) (at Glasgow).—L. A. Legros: Traction across Rough and Roadless Country (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch) (at Cardiff).

FRIDAY, JANUARY 9.

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Miss Beatrice Saxon Snell: Anglo-French Building Terms.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—N. Simpkin and F. S. Sinnatt: The Melting Point of Coal Ash. Part 2.—Prof. H. S. Taylor: The Properties of a Catalytic Surface.

WEST CUMBERLAND SOCIETY OF CHEMISTS AND ENGINEERS (at Workington), at 7.—E. H. Todd: The Structure of Matter.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—The Maintenance of High-Compression Oil Engines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Keighley: Colour and Sunshine: Some Mountain Villages of Southern France.

INSTITUTE OF METALS (Sheffield Section) (at Sheffield University), at 7.30.—A. H. Mundey: Die-casting.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.30.—J. L. Taylor: Theory of Longitudinal Bending of Ships.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch) (at Leeds).—H. W. Bannister: The Scientific Treatment of Boiler Feed-Water.

INSTITUTION OF MECHANICAL ENGINEERS (Liverpool Branch) (at Liverpool).—L. A. Legros: Traction across Rough and Roadless Country.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section).—R. F. Battey and J. Black: Debate on Diesel Engines: Four-Cycle *v.* Two-Cycle.

SATURDAY, JANUARY 10.

INSTITUTE OF METALS (London Section) (at Institute of Marine Engineers), at 7.30.—Dr. R. H. Greaves: Extensometers.