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Scientific Men as Administrators.

FREQUENT reference has been made in these columns to the relative positions of administrative officers and of scientific and technical officers in the service of the State. As we remarked when discussing the report of the Royal Commission on the Civil Service (Nature, Aug. 8), proficiency in science whether pure or applied is regarded almost as a disqualification for a high administrative post, the suggestion being that knowledge of a particular branch of science makes a man biased in favour of that branch. The corollary of this proposition is that the best administrator is one who has no scientific knowledge at all, even though every day he has before him problems which can only be understood and solved with the aid of science.

It is not strange that this paradoxical condition of things should have resulted in much dissatisfaction among scientific and technical officers in Government service, both in Great Britain and overseas. They find themselves frequently in distinctly inferior positions in comparison with those occupied by men who graduated in literary or historical subjects, and their rates of pay as well as promise of promotion are similarly on a lower scale, purely because they chose to take science for their degrees. No one could suggest for a moment that a science student is essentially of lower mental capacity than one whose inclinations are in literary fields, and it cannot be held that the knowledge and training he receives in his scientific course are detrimental to efficient service in a modern State. Notwithstanding this, we find that of two men with equal academic distinctions in the two different fields, one with a science degree is expected always to be subordinate to his fellow who graduated in ancient languages and literature.

Specialists are largely employed as a matter of insurance to safeguard the production of animal and plant materials and of minerals, or to watch over the health of the community. The last function is carried out by the medical officers, who are members of a well-organised and by no means inarticulate profession. It is far otherwise with most specialist services, and here the differential rate of pay, which particularly in a Colony may mean a lower position and social life, is a serious matter.

The problems to be considered by the scientific man in the Colonial Services are not those of his own choice; they are governed by local circumstances. Text-books and laws to which he can refer are non-existent, for the difficulties of each country have an individuality of their own. Such a man is paid on an average about twenty-five per cent less than his brother of equal academic standing, from the same university, who is in the administration—and this is often associated with longer terms of service, fewer higher posts to which he can aspire, and always by a relatively lesser pension. As compared with an academic career, the initial pay and security are often better, but there are singularly few posts carrying salaries equal to those of professors in the greater universities. The relative liberty of the latter is so well known to their students that those with the highest academic distinctions prefer teaching and research to State service.

Of course, especially in modern civilisation, the State must employ men of the highest class in all its services. This is particularly the case in the Civil Service, which was the concern of a Royal Commission in 1912–14. A Treasury Committee (1917) afterwards remodelled its examination through which the Higher Civil Service, the Indian Civil Service, and certain Foreign Office, Consular, and Colonial Services are recruited. In this examination all candidates must first qualify in a section which allows 100 marks each for five compulsory subjects, namely, essay, English, present day (questions on contemporary subjects), everyday science, and auxiliary language, and 300 marks for vivâ voce. In another section 1000 marks are distributed, *at the choice of the candidate*, amongst sixty-one subjects that represent every side of the teaching of universities. The age limit is twenty-four; and the examination is obviously arranged in reference to university courses of instruction. The following sciences are represented by papers of Lower and Higher Grades, for each of which 200 marks is offered, and both grades of which can be taken: chemistry, physics, botany, geology, physiology, and zoology. Of kindred subjects a candidate can take five papers, each of 200 marks, in mathematics, and usually there is little blending of this subject with science. The same remark applies to engineering and geography, to which are severally assigned 400 marks; to two sections of anthropology, each 100 marks; and to agriculture, 200 marks.

Science candidates have little to criticise, for the compulsory subjects represent a necessary, minimal, general education. Still less can they object to the vivâ voce, for it is the only practical means of estimating personality, especially as seen in the gifts of sympathy, readiness, and resource. In any event, it reduces an element of uncertainty common to all examinations, and the pure examinee will be accepted even if he possesses none of these gifts, and it is to be hoped that his deficiencies will be hidden in a useful, impersonal job. The study of the marks assigned in the vivâ voce is interesting, for it shows that the qualities sought are not peculiar to candidates from any single class of life or of learning, the examination being above suspicion.

The small importance of the subject of "Everyday Science" is perhaps more open to criticism in a State which largely owes its position to the application of science. The average individual would understand, by such a title, an elementary knowledge of his own actions and of the world around him. The examiner (1930) is apparently dominated by academic teachings, since candidates are asked about relativity, molecules, and atoms, the distance of heavenly bodies, adaptations of birds for flight other than wings, communal life among insects, and so on. To judge by the marks, this was a satisfactory paper, but such questions could be answered better by judicious cramming than by a general scientific education. In the separate sciences the Higher Grade is of similar standard and type to that of the final honours examination of universities, and so should afford a reasonable scope to specialists in science.

The schemes of the voluntary papers are all on the same lines; they include all the subjects taught in universities, and thus reflect the life and requirements of the nation. To ensure a Civil Service ready for all emergencies, each side of educated thought and progress should be adequately represented therein. It is accordingly evident that if any branch of learning, which is vigorous and promising in the country, should show numerical poverty in the Civil Services, there is a condition which calls for explanation and possibly remedial measures. Applying this criterion to the present state of the Civil Service, we find there a startling lack of scientifically educated men. In these circumstances it is difficult to understand how the independent scientific services of the State can be understood and properly used by an administration unfamiliar with the methods and aims of scientific workers. Here are the analysed figures for the higher examination of the Civil Service for 1930:—For the Foreign Office and Department of Overseas Trade, only 1 candidate out of 67 took any of the voluntary scientific subjects. For the Home Civil and Indian Civil Services and for the Eastern Cadetships there were 316 candidates, of whom only 20 presented science as the predominant group of their choice. Of these, 17 offered lower and 9 higher chemistry; the number in physics was 15 and 10; botany, 4 and 3; geology, 5 and 1; and zoology, 4 and 3. There were no candidates in physiology; 4 candidates sat for engineering, and 2 for geography.

Civilisation being so closely coupled to-day with the developments of science, these figures reveal a position which should be altered. These cover every field in Great Britain and the Dominions, but at present are mainly biological in the Crown Colonies. The basal factor in the latter is the native of the country, who is being profoundly altered by the introduction of hygienic conditions. The problem of the 'poor whites' in the Southern States of America has its counterpart in almost every Oriental country. Malaria, yellow fever, bilharzia, and a host of other diseases are ceasing to be endemic in successive generations. As a result, the future natives of many of these countries are likely to be physically and mentally superior to their ancestors. To-day there is everywhere an increasing call for science in the development of the races themselves and of the countries which they occupy. It follows that success in administration here will increasingly depend not on the knowledge of the history of colonisation and of the theories of governance, but on the scientific understanding of the changes wrought in the last hundred years and of the psychology of the governed.

Teachers of science must wake up to their responsibility in this matter, which is to direct the attention of suitable candidates to the needs of the State. For research, students of peculiar aptitude and mentality are required, and they for the most part desire to concentrate on one section of natural phenomena. There is a bigger class who have no such predilections in the early stages of their work. They want to understand all the diverse sides of science—physical, chemical, biological—with often a special fancy towards the economic, rather than to follow out any one line. They are as fitted as any other students for appointments in administration, and it is to this class that the Empire must look for its future administrators. Such men would have peculiar sympathy with the work of scientific men in their districts and encourage the application of their economic results. Their knowledge would inevitably create in themselves a deep interest in the country in which they dwell, thus adding to their happiness and efficiency. A special responsibility therefore rests upon those at the universities who have it in their power to influence likely science students to compete for administrative posts in the Civil Service.

Jules Janssen, 1824–1907.

Œuvres scientifiques. Par Jules Janssen. Recueillies et publiées par Henri Dehérain. Tome 1. Pp. vii + 545 + 12 planches. Tome 2. Pp. 648. (Paris: Société d'Éditions géographiques, maritimes et coloniales, 1929.) n.p.

THESE two imposing volumes are the second fruits of the devotion of Mlle. Janssen to the memory of her father. On Janssen's death, in December 1907, she took upon herself the task of raising a memorial of his long and distinguished scientific career, and with the co-operation of M. Dehérain, whose father and Janssen had been close friends from boyhood, a fund was accumulated for the erection of a monument on the terrace of the observatory at Meudon, which, during a period of more than thirty years, "he had paced with slow and regular step". The undertaking was on the point of consummation when the War supervened, and, laying aside all other considerations, Mlle. Janssen devoted herself throughout the ensuing period of hostilities to the care of the wounded. At the conclusion of the War this project was resumed, and on a beautiful afternoon in October 1920, a distinguished company paid homage to the memory of the dead astronomer.

Monuments are symbols; but a great man's works are realities; they alone are his true memorial. During his long life, Janssen wrote much but he never published a book. Mlle. Janssen accordingly began the collection of the articles and the writings which her father had contributed to various periodicals, and in this again she had the assistance of M. Dehérain. Unhappily, she has not lived to see the completion of this second mark of filial devotion. Among her last wishes was the desire that M. Dehérain would carry the project to fulfilment, and the volumes before us testify that he has discharged his commission in a manner of which she would assuredly have approved.

Janssen's long list of scientific works began in 1859, with a carefully prepared and illustrated paper describing experiments on a property of the eye relative to radiant heat—a thesis which was presented for the doctorate of physical science to the Faculty of Sciences of Paris. This involved him in some correspondence, and later in work with the ophthalmoscope. It was a natural transition from this to the spectroscope and spectrum analysis, which, in its turn, directed his attention to the heavenly bodies, and thenceforth Janssen's labours were almost exclusively astronomical in character. His first astronomical problem was concerned with the possibility of detecting the existence of a lunar atmosphere by means of the spectroscope. Many years later he returned to this subject and was able to settle the question definitely by observations of a partial eclipse of the sun.

Janssen's name will long be remembered through two brilliant pieces of work—his invention of the method of observing solar prominences in full daylight, and his beautiful and still unrivalled photographs of the solar surface, showing the granulations which he named the "réseau photosphérique". The former achievement, which, as is well known, was announced to the Paris Academy of Sciences simultaneously with that of an identical but independent discovery by the late Sir Norman Lockyer, might almost be said to be the most important event in the history of solar physics, for with it began the long and extremely fruitful course of observation—aided later by the spectroheliograph—which has culminated in the present physical theory of solar and stellar atmospheres. The French Government was not slow to recognise the significance of the discovery, and it at once set about the establishment of an observatory for Janssen, which, in spite of the disastrous war of 1870–71, was erected, first at Montmartre and later, in 1876, at Meudon.

Mention of the Franco-Prussian War reminds us of Janssen's historic escape from besieged Paris by balloon to observe the solar eclipse of December 1870. "En dépit du siège," he wrote to the Academy in October of that year, "et sans avoir à demander à nos ennemis le passage à travers leurs lignes, un observateur pourrait, au moment opportun, se diriger vers l'Algérie par la voie aérienne ; il emporterait seulement avec lui les parties les plus indispensables de ses instruments, sauf à les compléter à Marseille avant l'embarquement. Si l'Académie veut bien m'accorder son appui pour la continuation des travaux dont je viens de l'entretenir, une partie des ressources pourrait être employée à la réalisation de ce projet et je m'offrirais pour tenter ce voyage, heureux de donner ainsi à la science ce témoignage de mon entier dévouement." The observations, unfortunately, were ruined by clouds ; but the incident is eloquent of the ardent spirit of the man.

These are the achievements by which Janssen is mostly remembered ; but it should not be overlooked that much of his other work has become so absorbed into the traditions and common data of astronomy, that its authorship is almost forgotten. It was Janssen who gave us the term 'telluric lines', and he not only did work of fundamental importance in identifying such lines, but also placed their origin beyond doubt by observing them in the spectrum of a bonfire at a distance of 13 miles. For his observations of the transit of Venus in Japan in 1874 he invented a "revolver photographique", which is, in principle, the modern cinematograph, yet who thinks of Janssen in connexion with that device now ?

The volumes under consideration, which are enriched by some beautiful photographs, tell of a long lifetime devoted with conspicuous success to the service of science. M. Dehérain has done his work well ; he has given us a fitting memorial of a great man.

Physical Attributes in Plant Processes.

Life Movements in Plants. Edited by Sir Jagadis Chunder Bose. (Transactions of the Bose Research Institute, Calcutta, Vol. 6, 1930–1931.) Pp. vi+211. (London, New York and Toronto : Longmans, Green and Co., Ltd., 1931.) 18*s*. net.

IT is now almost axiomatic that, to get what you want involves continuous perseverance, often patient repetition, and sometimes decades of undivided attention and devotion. Perseverance underlies the success of things which primarily may have seemed impossible. Men and women have fought, have devoted their lives, and have even given their lives, in order to achieve the apparently impossible. Some aims are impossible, and that is one reason why, whereas some champions have been successful in reaching their ultimate goals, others have fallen by the wayside.

We wonder into which category Sir Jagadis Chunder Bose will ultimately be placed. For about thirty years now, he has fought the cause of the physiological against the purely physical in plant physiology ; also to prove that plants and animals exist by virtue of the same inherent phenomena. "The results of the experimental investigations that have been carried out in my Laboratory during the last thirty years suffice to prove that the mechanism as well as the life-processes in the plant and in the animal are essentially similar." His prolific publications go to show his firm conviction of this.

The physiological concepts of Bose, his firm belief that physiological phenomena succeed in explaining where physics fail to explain certain life processes, are well known to every experimental physiologist. To lift the science of plant physiology from the morass of chemistry, physics, and mathematics and to relegate it to a more exclusive position has been the life-work of this experimentalist—this maker of a mixture of poetry and science, as Prof. Donnan chose to call him. Bose is not only convinced of such possibilities, but also believes them to be proved. But we are still looking forward to the time when more of the 'physical physiologists' enter the lists with our physiological knight-errant and bring the issue either to a more definite understanding or, better still, a decisive climax, one way or the other. This state of scientific chaos, which exists in the mind of the physiologically interested onlooker, seems to be due apparently to two reasons: one, Bose's ignoring the work of his contemporaries to a large extent, and the other, the silence of his contemporaries; the latter probably being the more cogent.

This new publication helps the reader little in this respect. It is edited by Bose, who himself contributes short essays, interspersed as introductions to the other papers; but every author of the various chapters is a worker at the Bose Institute and, judging from the work done and the conclusions arrived at, each one seems to have imbibed to the full the philosophy of his director.

Many interesting new experiments are recorded, with methods constructed on true 'Bosian' lines, which need no introduction to the physiologist; but nothing very new is added to our stock of knowledge, hypotheses or contentions, where plant irritability and the ascent of sap are concerned.

We would rather see references to such works as Pfeffer's "Plant Physiology" and "Strasburger's Text-book of Botany" omitted in favour of more up-to-date works, and the conclusions of contemporary plant physiologists either made compatible with those of the vitalist or completely and irreparably refuted. But probably the others are really to blame. An almost eerie silence has pervaded this branch of botany for some years, which leaves us almost bewildered with perplexity. What is the reader to believe?

The revival of a drooping leaf on irrigation, and correlated experiments, demand much attention of Bose and his co-workers in "Life Movements". The rapid erection of a wilted, vaselined leaf on irrigation, as shown by Bose on pp. 14 and 15, and the failure of a poisoned leaf, similarly treated, to respond to the supply of water, certainly seems, as the author claims, to demonstrate the presence of some type of propulsive activity within the plant, which is independent of transpiration. The attainment of the erect position in about three minutes is indeed very quick, unless *Centaurea lanata* is a physiological monstrosity. The experiment is simple enough, 'fool-proof' as Bose described some of his experiments at the meeting of the British Association at Oxford in 1926. Why other physiologists cannot check such a conclusion by simple repetition of the experiment, especially one which is so antagonistic to the generally accepted conceptions (so far as we dare have any) of the ascent of sap, is very difficult to understand.

Chapter iii. is devoted to further work along the same lines on the characteristics of the erectile response of leaves, by U. C. Sen. Varying conditions are examined and their results recorded. Bose himself, in Chap. iv., describes his 'diagnostic' methods for recording erectile response of the leaf by the electromagnetic tapper and the automatic recorder. Not so 'fool-proof', we imagine; for, here, Bose is in that electrophysiological element peculiar to his own ingenuity. Further conditioning factors are examined by G. P. Das in Chap. v.

The effect of temperature of the water of irrigation on the rate of the ascent of sap is recorded by J. P. Sirdar in Chap. vi. Very important data are brought to light. Suction is annulled below 5° C. and then follows a steady logarithmic curve to 35° C. At the maximum temperature, investigations ceased. This is surprising in a worker who has clearly boosted the physiological against the physical. At just above 35°, many plant physiological processes begin to fall off, owing to the so-called killing of the tissues. In these inquiries, with vital propulsions and rhythmic activity at issue, we should expect that studies of the effect of temperature just above 35° would have been equally as important as those below. The results obtained from such temperatures and incorporated in the graph on p. 69 might have proved of the greatest utility. It is a pity that this has not been done, especially since previous experiments with water only at temperatures of 4° and 30° and 4° and 35° gave results which might have been expected, whatever view of the mechanism of the ascent of sap we are prepared to accept.

The effect of various normal and artificial factors on the pulsatory movement of the leaflet of the now too familiar *Desmodium* constitutes the basis of the work by Bose and Deb, recorded in Chap. viii. Here, again, greater value might have been attached to the results, when examining the effect of temperature, had the investigators used several temperatures *seriatim* instead of the minimum of 4° and the optimum (?) of 35° only.

Coming to the identity of plant with animal mechanisms, B. K. Dutt, in Chap. xii., shows that just as excitatory impulse is initiated by a specific polar action of an electrical current in the conducting nerve of an animal, so it is in the case of plants. Observations were made at different values of E.M.F. Another all too familiar plant, *Mimosa*, was used as the subject. After all, such plants are almost physiological freaks, and to generalise from such particular cases is scarcely good logic, or fair play. Bose and N. N. Das carried out similar experiments on the nerve tissue of *Bufa melanosticus* and, having obtained like results, conclude that "The results conclusively prove that the transmission of impulse in plants is an excitatory process of the same nature as that of the nervous impulse in animals". Similar conclusions are arrived at as a result of experimentation with the nerve of *Rana* and also *Mimosa*. But all this conveys nothing new so far as theoretical conceptions are concerned.

The book concludes with some work by Prof. N. C. Nag and H. N. Banerjee on the "Proteolytic Enzymes in *Carica papaya*" and by Nag and K. N. Bose on "Chemical Examination of some Indian Medicinal Plants". Nag and Banerjee disagree with Willstätter, who considers that papain contains only a single protease, and this of a tryptic nature. Their findings come more in line with those of Vines, who states that there are two enzymes present, one of a peptic nature and the other ereptic. In this chemical work it is refreshing to see contemporary and past investigations taken into account, which considerably enhances the value of the results obtained.

This chronicle of contemporary work being done at the Bose Institute, Calcutta, gives us very little that is now startling. Yet it serves one valuable purpose. It supplies much evidence which may easily be verified by other workers. We should like to see this done; but are beginning to despair of such hope. In any case, the book should be on the shelf of every physiologist, for if he is sympathetic with the views of Bose, it will help to give him still further satisfaction. If, on the other hand, he supports the more physical views and prefers to segregate plant from animal processes, the book should give him another opportunity for putting his own house in order. But we doubt if the book will carry enough conviction to change the opinions of anyone.

L. J. F. B.

Living Zoology.

Principles of Animal Biology. By Prof. Lancelot T. Hogben. Pp. xxiv + 332. (London: Christophers, 1930.) 8*s.* 6*d.* net.

THE main problem before the writer of an elementary text-book is usually what to leave out. Prof. Hogben, by leaving out most of the contents of other elementary text-books, has succeeded in writing a book which should interest not only the intelligent student, but also his teacher. Throughout it the animal is dealt with as a group of events rather than a structure. The anatomy of the circulatory system is only considered after a general account of its physiology has been given; the brain and its nerves are rather summarily described after a more detailed account of reflexes and the behaviour of isolated nerves and muscles.

What is more, zoology itself appears as a growing and far from adult science. The second part of the book is devoted to genetics and evolution, and comparative anatomy is introduced not as an end in itself, but as a means to classification. Thus the molluscs are described to explain why Cuvier's classification was superior to Lamarck's, and the cœlenterates in turn justify Leuckhart's emendation of Cuvier. So much space is devoted to the evolution of zoology, that the even more fascinating though more speculative study of the evolution of animals is perhaps treated a little summarily. Thus the clearest demonstration of evolution is to be found in the study of continuous change in such organisms as *Micraster* or *Gryphæa*, and some account of these gentes might have been more appropriate than a repetition of Dr. Buckland's alleged joke about glacial striation.

A very satisfactory account of elementary genetics is given, though this does not include the fact, which might have induced the author to alter the argument of his last two pages, that organisms can now be produced experimentally which will breed freely together, but not with their parents. A set of problems in genetics, though well chosen, unfortunately refer entirely to the domestic fowl and *Drosophila melanogaster*. Just as good data could have been obtained from the genetics of men, other mammals, fish, crustaceans, and gastropods. It would seem that the very men who are trying to dethrone the old morphological types such as the frog and dogfish are in danger of setting up *Drosophila*, an animal whose genetics are far from typical, as the principal genetical type.

It is doubtful how far this book will be adopted as an elementary text-book of zoology. Undoubtedly a medical student who had mastered it would be far better prepared for his medical studies than is now usually the case. But from what one knows of the history of university teaching, so violent a change is improbable. If it is made at all, it is likely to be made in stages. Meanwhile we can think of no volume of its size more suitable than Prof. Hogben's to supplement the orthodox zoological text-book, in the hands of both intelligent students and teachers. In this capacity, at any rate, it is to be hoped that it may find a wide circulation.

Short Reviews.

The Origin of Life. By Gilbert Rumbold. Second Impression. Pp. 128. (London: The Norfolk Press, 1931.) 5*s.*

The true philosophical mind is not connoted exclusively by an ability of learned and scholarly criticism of existing theories, but primarily by the inquisitive attitude which has really given birth to philosophy, and the courage and power of stating one's findings about the problems considered. The author of "The Origin of Life", though not a professional philosopher, displays in his book a true philosophical mind in presenting to us his particular answer to the time-honoured question which he asked himself, "What is it all about?"

Seeking unity of structure and purpose in the world in which we live, the author claims to have found a more adequate explanation of life by means of his "Proton Theory of Living Matter". This theory, which reminds one of a combination of Epicurean physics with Leibnizian monads and Darwinian selectionism, the whole mashed with the language of contemporary physics, is simple and suggestive. In order to bridge the gap between mind and matter, the author imagines the existence of 'egos' or 'earth-minds' of which human minds are but a sub-class. These 'egos' have the property of expressing themselves in the world of matter, the size of their 'modes' of expression being no wider than the proton nucleus of an atom. Then intervenes the principle of natural selection, which directs the 'egos' to meet other 'egos' and thus form the original cells of the living matter. The establishment of a proper hierarchy between these formations leads to an all-embracing explanation of life, while secondary developments of this theory offer tentative explanations of habit, instinct, sex, and suggest possible solutions of some higher problems of philosophy.

These views are indeed very interesting; but before discussing them in detail, one would wish Mr. Rumbold to expand his epitome in such a way as to show exactly the intermediary steps between his dogmatic assertions, and to indicate the connexion of some of his expressions with the standard theories they inevitably conjure up in his readers' minds.

T. G.

Annales de l'Institut Henri Poincaré. Fascicule 2, Vol. 1. Pp. 77-203. (Paris: Les Presses universitaires de France, 1931.) 35 francs.

The first number of the *Annales* was noticed in Nature of Oct. 11, 1930 (p. 564). In the second number we have de Donder on Einstein's theory of gravitation, Pólya on some points in the theory of probability, Lévy on the fundamental theorem of the theory of errors, and Kostitzin on some applications of integral equations.

De Donder's paper is a summary of a series of six lectures dealing not only with relativity, but also with wave mechanics and thermodynamics. He tries to show that, contrary to a widely held belief, there is no need to modify the general theory of relativity, for if this is understood in a sufficiently wide sense it is in harmony with the most modern theories of wave mechanics. There are several references to the work of J. M. Whittaker, and it is pointed out that the material tensor, the electric current, and the photonic currents properly so-called are all expressible in terms of Whittaker's photonic potentials.

Pólya's paper is divided into two distinct parts. The first deals with a characteristic property of the Gaussian or normal law, while the second deals with other laws of frequency, obtained by the superposition of small causes which are not independent of one another. Lévy's paper also deals with the normal law.

Kostitzin's paper deals with integral equations which have an infinite number of solutions. He advances the view that by restricting ourselves to linear equations with unique solutions we get an impression of definiteness and causality in Nature which is valid only as an approximation. The multiplicity of solutions corresponds to the more modern view of indeterminacy in detail, with definiteness arising only from a statistical average. In an interesting preface it is suggested that the sceptical and even pessimistic tone of Poincaré's last utterances on the physics of his time was due to his insight into its concealed weakness and his power of anticipating future developments.

H. T. H. P.

Animal Ecology and Evolution. By Charles Elton. Pp. 96. (Oxford: At the Clarendon Press; London: Oxford University Press, 1930.) 4*s.* 6*d.* net.

This little book consists of three lectures, "The Regulation of Numbers", "The Significance of Migration", and "The Real Life of Animals". An environment is an entity composed of plants and animals, the species of which are constant. But it is pointed out that the numbers of the different species of animals vary not only in accordance with the periodic changes of temperature, rainfall, etc., but also in an irregular manner. There may be an optimum density for a species and, when its population varies too far from this, the species changes its behaviour. The most obvious change is that of migration into a region which may be very different from its old home, a new habitat. It seems to be an inherent impulse, for the individuals which migrate are often annihilated, without in any way eliminating the impulse in the species when the disadvantageous circumstances which caused it recur.

The emphasis on migration rather hides the fact that every free living animal has in the small affairs of its life a considerable amount of freewill. Examples are given, all from air living animals, but we think they would be easier to understand and found to be even stronger in aquatic forms. The third part is really an examination of these views with regard to the current conceptions of evolution. The idea of all structure in animals having an adaptive relation to the environment is surely out of date amongst zoologists, as also is the formation of species by natural selection by the accumulation of small variations. The whole question of mutations arises, and we agree that "without the aid of any adaptive advantage" such will never be able to spread beyond a certain point. But, if mutation has once occurred, the potentiality is there in the species and it may often reappear. We do not propose to follow the author in his discussion. We content ourselves with thanking him for indicating many sides of the study of living animals that may be pursued with advantage. J. S. G.

The Heavens and the Universe. By Prof. Oswald Thomas. Translated by Bernard Miall. Pp. 288. (London: George Allen and Unwin, Ltd., 1930.) 7*s*. 6d. net.

This book has been written by a star-lover for star-lovers. It is couched in simple, conversational language, suitable for the earnest but not very learned mind. The author has for many years been accustomed to conducting night excursions into the woods near Vienna for the purpose of observing and studying the heavens, and he here tries to extend the usefulness of his talks to a wider circle. He has done very well. The book will appeal to the many persons whose interest in the sky will always be primarily a sentimental one, but who, nevertheless, feel a desire to know something of what the astronomer by his cold, intellectual inquiry has been able to discover. Prof. Thomas tells him this in a way which he will appreciate; the style is humane without undue preciosity. Anecdotes are common and usually to the point, and the illustrations have been successfully conceived.

The professional astronomer will probably meet with statements which will seem to call for criticism, but if he is wise enough to remember the purpose of the book he will turn a deaf ear to them. They are, in any case, few and of little significance, and the negative virtue of freedom from inaccuracy counts for little beside the many positive virtues which characterise the book. The translation—which achieves the merit of not being recognisable as such—is very satisfactory. Prof. Thomas's book is possibly the only popular astronomy which contains no photographic illustration. This, it must be confessed, is a defect, but the reader will probably have become so familiar with some of the admirable celestial photographs now available in such a variety of ways that the disadvantage will be reduced to a minimum.

Intermediate Mechanics. By D. Humphrey. Vol. 2: *Statics and Hydrostatics.* (Longmans' Modern Series.) Pp. xi+438. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 10*s*. 6*d*.

This very competently written volume, designed to cover "all requirements up to Higher Certificate and University Scholarships standard", leaves one with a dream-like feeling that the Saturnian days of the old Cambridge mathematics have not yet passed away. Here are no philosophic doubts concerning the definitions of force and matter; a balance must still be (i) *true*, (ii) *sensitive*, (iii) *stable*, and (iv) *rigid*; the conventional systems of pulleys are carefully and clearly explained, with illustrative examples of every degree of ingenuity, and not so much as a picture of a Spanish Barton; and all our old problems concerning rods in bowls, jointed rhombuses, slipping ladders, sliding rings, jamming drawers, and examples of practically every type of question that the perverted imagination of an examiner can suggest, are assembled under their due headings and worked out in clear and orderly fashion. The book expands beyond the limits usually assigned to such work in well-written and fully illustrated chapters on beams and catenary problems, on graphical statics, and on virtual work.

There is no doubt that the book will provide all the guidance necessary for candidates taking examinations of the Intermediate standard, and will serve as a useful introduction to more advanced work. Whether books of this type are of real assistance in the training of engineers or of mathematicians is a matter concerning which we do not express any opinion. A. F.

A Compilation of Culture Media for the Cultivation of Micro-organisms. By Prof. Max Levine and H. W. Schoenlein. (Monographs on Systematic Bacteriology.) Prepared at the request of the Society of American Bacteriologists and financed by a Grant from the Digestive Ferments Company, Detroit, Michigan. Pp. xvi+969. (London: Baillière, Tindall and Cox, 1930.) 67*s*. 6*d*. net.

This large volume is a compilation of various media used for the cultivation of bacteria, yeasts, and moulds. In all, about seven thousand have been assembled. These have been subdivided primarily into groups on the basis of physical characteristics and the nature of the solidifying agent used, and secondarily upon the chemical characteristics of the media. The use of each medium is indicated.

The book is one of a series of monographs on systematic bacteriology and was prepared at the request of the Society of American Bacteriologists. References are given with each medium, and an excellent list of references at the end of the volume. The compilation of so vast an amount of scattered material is difficult, and has been admirably done. The book is a valuable addition to bacteriological literature.

The Ecological Viewpoint.*

By Prof. J. W. Bews, Principal of the Natal University College.

THE study of the history of science, and particularly the detailed history of single sciences, is of very great importance for all scientific workers. The history of botany is as interesting as any. As the content of the subject, like other sciences, increased so vastly during its development, specialisation in modern times became inevitable. Specialisation in itself is not necessarily a bad thing, indeed it is necessary for the progress of science; but by itself it is not enough. Specialisation should be combined with as sound a knowledge as possible of the subject in general.

The question is whether botanical specialisation in these days has become universal. Are there any botanists left who adopt the right attitude of mind? The answer is that this is exactly the claim put forward by the ecologist. Ecology, as its followers have maintained, is not a special branch of botany; it is simply a way of looking at the subject. The ecologist adopts what one might describe as the holistic point of view. Ecology seeks to explain, as fully as possible, not only why plants occur where they are found, but how and why they are as they are, and why they behave as they do. It is, therefore, essentially synthetic. It draws upon palæobotany, for example, because to understand why plants are as they are to-day it is necessary to study their past history. The study of plant pathology is essentially ecological because disease in plants, as in animals, is due to maladjustment to their environment. Experimental work in ecology, as Clements has pointed out, is purely a study of evolution, and the facts of the latter are the materials with which taxonomy deals. The value of genetics to the ecologist is sufficiently obvious. Ecology and physiology are clearly so allied that the latter may very well be included in the former.

South African Ecology.

In many ways in South Africa I was fortunate, for, when I began work here in 1910, I was brought closely into touch with the late Dr. Medley Wood, with Dr. T. R. Sim, with Dr. Marloth, Mr. J. S. Henkel, and others from whom I was able to learn a great deal in a comparatively short time. Descriptive ecology can, of course, be made as detailed as one pleases, but the recognition, description, and rough general analysis and distribution of the major plant communities in Natal and some other parts of South Africa could be carried through fairly rapidly.

The second stage of my South African ecological studies dealt with the developmental history of various plant communities, or what is commonly referred to as plant succession. One of the most important things is to be always on the lookout for cases of plant suppression, that is, examples of one type of plant being killed by another. For example, as one walks along the margin of a forest one can often discover the dead remains of light-demanding shrubs just within the outside belt of trees. This means that the forest is progressive and is gaining ground at the expense of the surrounding grassland. Similarly, in the grassland itself, tufts of deep-rooted wire grasses (*Aristida*) may be found being smothered by the more shallow-rooted, more luxuriant red grass (*Themeda*).

Everywhere, a dead or dying plant should act as a 'flag signal' to the ecologist. The immediate cause of death is usually the attack of some fungal or bacterial parasite. But the more remote causes are various, depending usually, in a general way, on the lack of power to respond to changes in the environment, and, since the biotic environment is most liable to change, death is most often brought about in this way. One stage of development of the plant community gives way to the next, until a climax, a more or less stable condition, is reached.

As soon as one has obtained a sufficient number of carefully recorded comparative observations in different areas, a complete analysis of the full developmental history of any plant community can be given, and, for the more important plant communities in South Africa, that has been done. Over the whole eastern side of South Africa the main course of the plant succession is similar to that found in other parts of the world. Bare surfaces are colonised by light-demanding plants, among which annual weeds and other 'ruderal' plants are common and characteristic. The earlier stages of all succession on dry land are more xerophytic than succeeding stages.

In a pastoral country such as South Africa, the proper management and control of the natural pastures is of paramount importance. It is possible to sum up almost in a single sentence what are the results of overstocking, veld burning at unsuitable seasons, and other modes of interfering with the natural vegetation. Man's interference always tends to send back the plant succession. Climax stages are destroyed and earlier stages take their place. Over wide areas of climax grassland this is undesirable, for the earlier wire-grass stages are less palatable and less nutritious. On the other hand, in forest climatic areas it may be a good thing to replace trees and shrubs by earlier pure grassland stages. A careful study of the plant succession can show us when burning the grass is necessary and when it is not. There are many other practical problems in connexion with veld management that can be solved by studying plant succession, plant indicators, and, in general, applying field ecological methods.

Pioneer species tend to be very widespread; they are more plastic physiologically; they show a greater range of physiological variation. It is also particularly interesting to note that pioneer species are usually to be regarded as advanced

* From the presidential address delivered on July 6 to the South African Association for the Advancement of Science, at Grahamstown.

types from the phylogenetic point of view. On the other hand, the species that belong to later stages of the succession differ in all these respects from the pioneers. They are much more numerous than the pioneers, and they belong to a greater variety of growth forms, since, in addition to the dominating species, there are so many that occupy subordinate positions. One of our South African forests, for example, does not consist merely of trees. There are abundant climbing plants, epiphytes, shrubs, undershrubs, and herbs, as well. Since they vary so much in form, so also they vary in their phylogenetic standing. Many of the trees are relatively primitive in this respect. Some of the subordinate forms may be very advanced. For the climax stages the living environment (or biota) is as important as, if not more so than, the inorganic environment.

The third phase of the ecological work which I have been privileged to carry out in South Africa followed naturally from the previous work. It consisted in the study of the interrelationships of taxonomy (based on phylogeny) and field ecology, and in particular dealt with the origin and migrations of the South African flora and the evolutionary history of plant forms. More recently I have applied the same methods to the study of a single group of flowering plants—the grasses.

By combining the study of taxonomy with the study of distribution it soon became apparent that the oldest flora lay to the north of us, in the great moist tropical areas of Africa. In support of this view is the further important fact that the tropical flora of Africa in many of its elements unites closely with the tropical floras of Asia and America. It is probably the oldest angiospermous flora in the world. In South Africa, from this tropical element, a subtropical one has been produced, which has become more and more highly evolved and modified in response to the winter resting season and dry conditions generally, until in our Karroo regions and dry desert areas of the western side we find the culmination of the process. The Karroo has a flora which has good claims to be ranked as the most highly evolved in the world.

The temperate element of our flora, however, is rather distinct from the tropical and subtropical. It is allied to the tropical, from which many of its elements have obviously been derived, but the temperate flora of the southern hemisphere occurring to-day in South Africa, Australia, and South America is undoubtedly a very ancient flora. It connects along our great mountain ranges of central Africa with the flora of the Mediterranean region.

The evolutionary history of plants can only be described with any degree of certainty when we know a great deal more, not only about palæobotany, but also about the past history of the world throughout geological time. With the aid of geology, the syntheses can be made more complete. The history of the flowering plants in the world has been mainly a history of response on the part of a widespread, uniform, moist tropical flora to climates which became gradually cooler and drier. In South Africa, owing to its relative geological stability ever since Cretaceous times, the whole process has had a longer time in which to take place, and, apart from certain climatic oscillations of which there is evidence, the process has not been interrupted in any drastic way, as would have occurred if large areas had sunk below sea-level. South Africa throughout the history of the flowering plants has been above the sea and has been joined to the tropical regions to the north. The derivative Karroo flora, therefore, is not only highly evolved but also, in comparison with similar semi-desert floras in other parts of the world, is a rich flora. Those arid plains have been colonised by families such as the Compositæ (regarded by all botanists as the highest of all plants), by relatively advanced members of other circles of affinity, for example, the tribe of Stapelieæ of the asclepiad family, the Mesembryanthemeæ among the Aizoaceæ, and so on. There is a magnificent field here for the study of plant colonisation on a grand scale. A comparative cytological investigation of the numerous species involved should at the same time be undertaken. The importance of isolation in the origination of new forms has long been recognised. Modern work in genetics has shown more clearly the reasons for it. They seem to depend chiefly on the fact that if a new form is prevented from interbreeding with the parent species then the chances of survival are enhanced.

The thing that interests us most for the moment is the undoubted fact that in South Africa we have unequalled opportunities for the study of the facts bearing on such problems. Ecology tends to unify the whole study of botany, and the adoption of the same point of view, with perhaps, to some extent, even the adoption of the same methods and technique, would, I think, tend to do the same thing for other biological sciences.

Human Ecology.

It is a very natural thing to inquire what bearing biological studies of any kind have on the life of man himself. Experience, however, ever since the publication of Darwin's "Origin of Species", and even before that, has gone to show that there is need for caution in applying biological theories to man. The point of view of no single one of the human sciences is broad enough to explain fully why man is as he is and why he behaves as he does. Ecology alone stands apart. The student of man and his works, whether he calls himself archæologist, ethnologist, anthropologist, sociologist, economist, geneticist, geographer, historian, educationist, psychologist, or physician, would do well to become more of an ecologist and try to adopt more and more the general point of view.

Plant ecology may be taken to include plant pathology, since diseases depend on a maladjustment to the environment. So human ecology should also include the study of medical science. Just as plant ecology binds together very effectively all the branches of botany, so human ecology should help to unify—so far as they can be unified—all the separate sciences which deal with man. No one, of course, can attempt to master them all, and no one would be foolish enough to advocate such procedure.

The development of the study of human ecology will probably follow lines similar to those followed by plant ecology. Man reacts to his environment as plants do, but man can control his environment in a way that plants cannot. Nevertheless, the point of view remains the same.

The first phase of human ecology must necessarily be descriptive. The greater the literature dealing with man is in point of bulk, the more need there is for seeking some means of determining the relative value and significance of all its varied content; and that, I feel sure, can be done by applying the test of its value to ecology. It is dangerous to press analogies very far, and it will almost certainly be found in practice that human ecology will not develop on exactly the same lines as plant ecology. The results obtained in the field of plant ecology must be applied with great caution when human communities are studied. At most they may be utilised to suggest hypotheses and useful lines of investigation.

Pioneer men, like pioneer plants, are more plastic in their reactions to the inorganic environment. If the environment is very adverse, complex plant communities cannot be built up; the pioneer stages remain more or less the final stages as well. This is equally true for human communities. The total numbers of pioneers among men as among plants are much smaller than those belonging to later stages of communal development. Pioneers among men, like their analogues among plants, tend to become widely scattered over the world. It is their business to conquer new habitats. They are ready to meet any emergency; they can fight their way through all the varied difficulties presented to them by Nature, but they fail to subordinate themselves to the community as a whole, when that becomes more complex. They remain pioneers and must always strike out along new pathways. They are stifled by the atmosphere of our great cities.

It is unnecessary to carry the analogy any further. It is enough if it has suggested to us that, fruitful as the comparison of pioneer and climax types in the plant world has been, a similar comparison of pioneer and climax types among men (without any reference to plant ecology) may prove even more interesting and valuable. I am aware, of course, that students of sociology have already contributed a great deal to the study of development in human communities: for example, Spencer, Bain, Mill, Hobhouse, McDougall, McIver, Graham Wallas, Westermarck, Saunders, and many others. But few or none of them, so far as I have discovered, have devoted much attention to the advances that have been made in plant ecology, or have adopted the ecological viewpoint. Nowhere could it be better carried out than in South Africa, where we still have almost every possible stage of development of human communities.

A comparison of different stages of development among human communities will probably at the very outset demonstrate quite clearly that our education policy in the past has not been a very wise one. Up to a very few years ago, we were teaching in all our South African schools (whether attended by whites, Indians, natives, or 'coloured' people) more or less exactly the same subjects. There has been and there still is far too much uniformity in our educational system. It is a mistake which is only slowly being put right, and it is doubtful whether it ever will be properly rectified until we carry through more intensive comparative studies of communal development such as I am advocating. In South Africa we are concerned not only with the development of a more or less uniform white race, but the problem is made more interesting and more complicated by the presence of a black race (not to mention the presence of South African Indians as well). The question at once arises as to whether two or more very distinct races can successfully occupy the same territory and, if so, under what conditions. More than ever is caution necessary if we try to apply results obtained in the study of plant ecology to such a problem. If two distinct races of man wish to occupy the same region, whichever of the two is the better suited to the environmental factors will in the long run succeed, while the other will fail.

We often hear the opinion expressed that South Africa is a black man's country. The white man, we are told, can only exist here by virtue of his superior intelligence, which enables him to dominate the blacks and force them to do all the really hard work. Some of the facts already established by plant ecology do seem to have an important bearing on this problem. The climate of South Africa is not tropical. Its vegetation is warm-temperate or subtropical, but not tropical; yet the Bantu peoples of South Africa are a tropical people that left the tropics and migrated southwards not so very long ago.

The idea that the black man is better suited than the white to the South African climate wants very careful consideration. It is true that so long as they do not come into very close and intimate contact with the white man, the black races can occupy and have occupied large tracts of land in South Africa, and that, too, at higher altitudes, such as Basutoland. On the other hand, during times of stress, for example, during the great influenza epdemic of 1918, apparently the black races suffered much more than the white. Those in the best position to know tell us that many diseases, such as tuberculosis, are spreading rapidly among the blacks, with disastrous results. But our information is all vague and unsatisfactory. I am not concerned now with possible explanations of these facts, if they are facts. What I do want to plead for is more organised systematic ecological research. It is surprising, in spite of the great advances in science during recent years, how little really scientific research work has been done on the kind of social problems that concern us most. I have said nothing about the mixed or so-called 'coloured' peoples of South Africa, though most of us probably realise that these present the most important and scientifically the most interesting problem of all, a problem calling for intensive research on ecological lines.

In conclusion, I should like to stress once more the importance of combining different lines of attack on any problem. However valuable specialised studies may be—and that they possess great value no one will deny—they must be combined with a study of each problem as a whole, and that, in its essence, is the ecological method. Of all the sciences which deal with man, modern geography, as it is studied in the best schools, perhaps comes nearest to what I have called 'human' ecology. It is human ecology, but it scarcely attempts to cover the whole field of what I would include in that subject. It has, however, largely adopted the ecological viewpoint. Similarly, the study of sociology on modern lines, so far as it goes, is pure ecology.

The study of human communities is not the only science which deals with man. Ecology has gone further than sociology in its efforts to synthesise. Human ecology is certainly concerned with social studies and should make full use of all the social sciences, but it should aim also at making equally good use of every other branch of humanistic study, in seeking as perfect an answer as possible to that all-embracing question of how and why man has come to be as he is and to behave as he does.

The Architecture of the Solid State.*

By Prof. W. L. BRAGG, F.R.S.

THE electrostatic basis of the interatomic forces explains in a very elegant way the structures of compounds which contain a number of ions of different kinds. The principle of electrostatic valency in such compounds has been formulated by Pauling.

Suppose a number of ions to come together to form a crystalline solid. The ions are of different sizes, each kind has a characteristic positive or negative charge, and their relative numbers are necessarily such that the whole structure is electrically neutral. How will they arrange themselves so that the electrostatic energy in the interspaces is as small as possible? The governing factors are those of size and charge.

The first feature is that of 'packing'. The ions will fit closely together in order to reduce the interspace with its electrostatic energy. The largest ions are the negative ones, which therefore have the main effect in determining the packing, and the positive ions fit into the spaces in between. To see what arrangement will make the electrostatic energy as small as possible, it is useful to make a picture of the structure in which the electrostatic field is represented by lines of force. These start from the positive ions and end on the negative ions, their numbers being determined by the charges. Our complicated three-dimensional condenser will tend to take up a form such that all lines of force have as short a path as possible.

The result may be illustrated by a structure such as that of beryl, $Be_3Al_2Si_60_{18}$, shown in Fig. 5. The large spheres are oxygen, and tucked between them one can see silicon (black), aluminium (shaded), and beryllium (white). The oxygens are the negative plates of the condenser, the other atoms the positive plates, and the packing is clear in the diagram. In order that all lines of force may have the shortest path, a certain relation must hold between the electric charges (Pauling's rule). Silicon has a valency 4, aluminium 3, beryllium 2. As shown in the lower part of the diagram, the lines of force Si^{4+} end on four oxygen ions, O^{2-}, thus balancing a charge $-e$ on each. Al^{3+} surrounded by six balances a charge $-e/2$ on each oxygen, and Be^{2+} surrounded by four also balances a charge $-e/2$. The same structure is shown as a skeleton in Fig. 6, and it will be seen that the oxygen atoms (large circles) are of two kinds, and that *each kind has its charge exactly neutralised.* One kind of oxygen is linked to two silicon atoms $(4/4+4/4=2)$ and the other to silicon, beryllium, and aluminium atoms $(4/4+3/6+2/4=2)$. There is thus local neutralisation of charge in the crystal, and our picture of lines of force is one in which they merely join one atom to the next, and those starting from a positive ion are not forced to wander to distant atoms in the crystal before finding an equivalent negative charge on which to end.

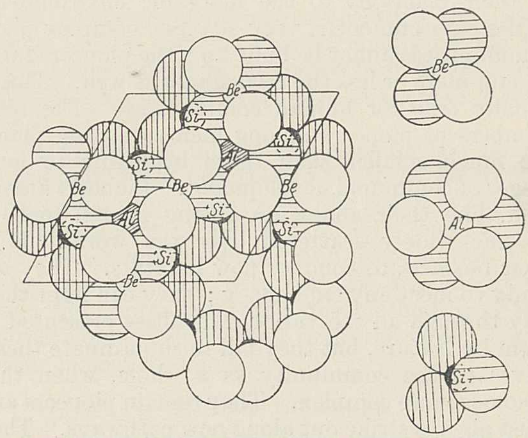

FIG. 5.—The arrangement of atoms in the structure of beryl, $Be_3Al_2Si_6O_{18}$. The large oxygen atoms are densely packed, and the atoms of metal and silicon are in the spaces between them.

It is surprising how the simple rule, with a few hints from X-ray analysis, enables one to build up very complex structures. One stacks the groups together, always obeying the electrostatic rule, and the whole crystal pattern falls into place. It is the electrostatic counterpart to the more rigid rule of valency in organic compounds, when each unit of valency is represented by a single indivisible bond. In the typical inorganic compound the valency can be divided into fractional parts, because it is due to an electrostatic charge, but it still remains true that when these fractional valency bonds between

* Continued from p. 212.

all the atoms are drawn the contributions of the bonds to every atom add up to its valency. As in the case of an organic compound, the formula of an inorganic compound cannot be expressed by a formula merely giving the relative numbers of atoms. The only complete formula is a model of the structure, showing the relationships of its constituent atoms; nothing less can express the valency laws involved.

Acid radicals, such as $(ClO_4)^-$, $(SO_4)^{2-}$, $(PO_4)^{3-}$, consist of four oxygen atoms surrounding the central atom. The group as a whole has a negative charge, and in a salt these groups are held to the positive ions by electrostatic forces. Now although an oxygen atom can be bound to one sulphur or chlorine atom in this way, forming part of an acid group, it cannot be bound to two without causing an intense localisation of positive charge, because the negative charge of the oxygen atom is more than balanced. Hence these acid groups generally only involve one central atom, such as sulphur or chlorine, rarely two or three. The position is different as regards silicon, for (as in beryl) an oxygen atom common to tetrahedral groups around two silicon atoms satisfies the rule as to equivalence of charge. There is thus no limit to the extent to which silicon-oxygen groups can link up, so that silicon builds a very characteristic class of compounds. The silicon-oxygen tetrahedra can form groups as in beryl, where each unit has the composition Si_6O_{18}. They can link by corners to form endless rows, like long negatively charged chains (Fig. 7). These are attached sideways by positive ions, and form characteristic fibrous structures such as asbestos. They are linked side by side to form extended sheets, as in mica, with positive ions between. When we split a piece of mica we are pulling apart the plates of a condenser. Each acid radical, negatively charged, extends as a sheet, over the whole mica surface.

So far we have considered the crystal as a structure with static equilibrium between the forces of attraction and repulsion. This equilibrium is disturbed when the crystal is elastically strained, or the atoms set in motion by heat vibration.

A very interesting result of X-ray analysis is that we can measure the amplitude of vibration of the atoms at different temperatures, as was first predicted theoretically by Debye, and shown experimentally by Sir William Bragg. A series of such measurements by James is shown in Fig. 8. The X-ray results can be used to make a picture of sheets of atoms in the crystal planes, and the peaks in the diagram represent a cross-section of the crystal density taken normally to certain crystal planes of sodium chloride. The large peak is chlorine, the smaller sodium. As the crystal is warmed, the sharp peaks become broadened, due to the vibration of the atoms, just as the image of an oscillograph is drawn out into a band when it vibrates. A very interesting feature, shown by James, Waller, and Hartree, is that even when the results are extrapolated to the absolute zero, the peaks are not so sharp as they should be according to Hartree's atomic models. The atoms appear to be vibrating even at absolute zero, and calculation shows that the vibration corresponds to the 'zero-point energy' of quantum theory. The extent of vibration is quite considerable at room temperature, and still greater nearer the melting-point. For example, sodium and chlorine atoms at room temperature have an average amplitude of $0{\cdot}22 \times 10^{-8}$ cm., and at 600° C. of $0{\cdot}6 \times 10^{-8}$ cm. as compared with their distance apart of $2{\cdot}8 \times 10^{-8}$ cm.

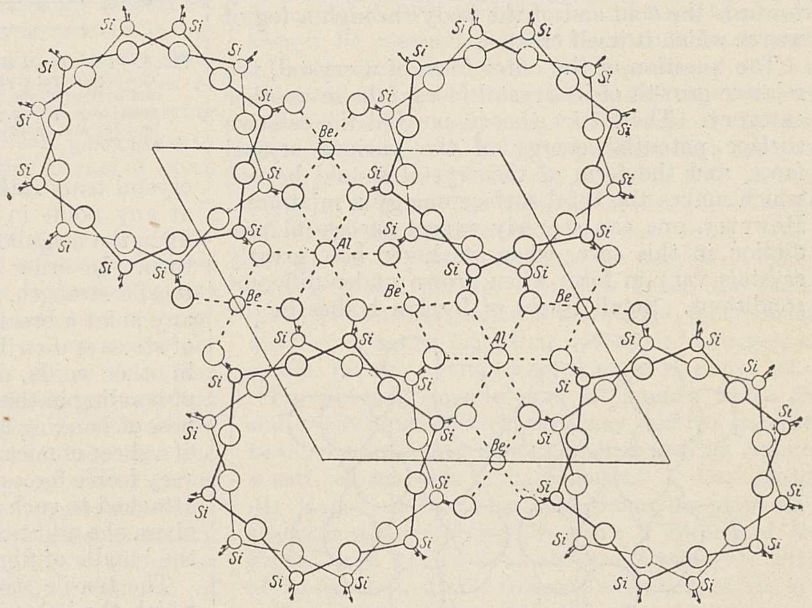

Fig. 6.—The structure of beryl arranged to show the way in which the two kinds of oxygen atoms (large circles) are linked to silicon and silicon, or to silicon, aluminium, and beryllium, in accordance with Pauling's rule.

We may think of the crystal as a three-dimensional spring mattress, the atoms being linked together by springs. Heat causes shivers to sweep backwards and forwards through the solid, displacing the atoms from their normal positions. Two most important properties of the solid are those of thermal expansion and thermal conductivity, and it was first pointed out by Debye that these effects are both paradoxical unless a refinement in considering the repulsive forces between the ions is introduced. If the restoring forces when the atoms are displaced were simply proportional to the displacement, bodies would not expand when heated. In the spring mattress model, an atom vibrating between two neighbours pushes the one towards which it is displaced and pulls the one from which it is displaced; on the average, such pushes and pulls cancel. But when a departure from the linear relation between displacement and force is taken into account, the pushes are increased and the pulls weakened. Each vibrating atom, then, helps to force the whole structure apart.

Thermal conductivity, in the case of those solids which are not electrical conductors, depends upon transference of atomic vibrations from hot to cold regions. The heat motion consists of waves, and if these waves traversed in the body quite independently of each other, any agitation at one end of the body would immediately rush to the other at the speed of elastic waves in the body. Hence thermal conductivity should be almost infinitely great. Actually the different wave-trains are not independent, but influence the motion of each other. They therefore scatter each other, and the advancing region of wave agitation has to fight its way towards the cold end of the body through a fog of waves which it itself creates.

The question of the outer form of a crystal, the relative growth of its crystal faces, falls in another category. The lattice theory can tell the relative surface potential energy of the various crystal faces, and the form of the crystal should be one which makes the total surface energy a minimum. However, one can scarcely expect successful prediction in this case, when we know how greatly crystals vary in form when grown under different conditions. Small traces of foreign bodies in the solution or liquid entirely alter the crystal form. The energy of the surface is too small compared with that of the crystal as a whole, and reacts too sensitively to adsorbed layers.

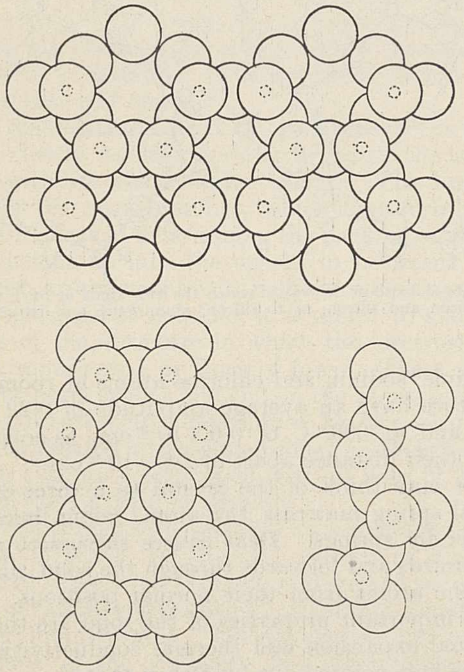

Fig. 7.—Chains and sheets of silicon-oxygen groups in the silicates. Silicon, shown as a small circle, always lies between four oxygen atoms and the tetrahedral groups are linked by sharing oxygen atoms.

In the explanation of the tensile strength, as ordinarily measured, the lattice theory breaks down entirely. Rocksalt should be rather stronger than the strongest steel, whereas Joffe has shown that it breaks under a stress only 1/500th that calculated theoretically, and explains this by supposing a crack always starts at a weak place and the crystal tears rather than breaks. An initial break at any point in a crystal concentrates the strain upon the neighbouring regions, which break in their turn. In order to get a body which has a high tensile strength, it must be ensured that, when at any point a break does occur, the resulting increase of stress is distributed widely. Tensile strength is, in other words, not so much a question of strength of bonding in the direction of the stress, as of weakness of bonding at right angles to it. The strength of a sheet of mica, or a fibre of asbestos, is due to the very feeble forces with which the sheets or fibres are attached to each other laterally, so that if one fibre gives, the additional stress is shared by the rest of the bundle of fibres.

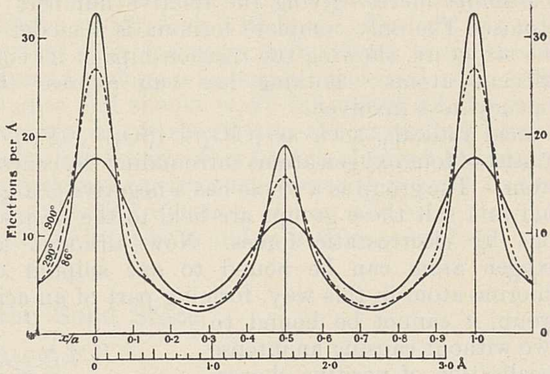

Fig. 8.—The vibration of the atoms when sodium chloride is heated. The octahedral crystal planes consist of alternate sheets of chlorine and sodium atoms, represented in the figure by the large and small peaks respectively. As the temperature is raised, the sheets become broader and more diffuse owing to thermal movement. (James and Firth.)

The tensile strength is one example of many in which the behaviour of the real crystal, built of a number of crystalline elements, differs from that of the ideal perfect crystal and requires a new type of treatment. X-ray analysis has always shown that actual crystals are composed of a number of small blocks, or ' mosaic ' as Ewald terms it, of crystals which are nearly in the same orientation, but not quite. There must be a misfit at the boundaries between these blocks. For some crystalline properties, such as heat of formation or double refraction, the mosaic structure has no influence. For other properties it is all-important, and tensile strength appears to be such a property. Smekal has always insisted on the important difference between the ' ideal ' and ' real ' crystal, and believes many properties to be essentially dependent upon it.

Thus, when one considers the properties of the solids which are of technical importance, in contrast to those of the ideal crystal, little success in exact interpretation can be claimed. However, the knowledge of atomic arrangement has performed a service, the usefulness of which is not so obvious, but is yet very great; it has provided a new language, or series of conceptions, in which to express the vast amount of empirical knowledge about the behaviour of materials which has been accumulated.

News and Views.

THE subject of noise and its measurement, dealt with by Dr. G. W. C. Kaye in his recent Royal Institution discourse, which forms our supplement this week, is one of great practical importance and wide interest. It is becoming increasingly apparent that excessive or particularly irritating noise is injurious to health, happiness, and working efficiency. Laboratory measurements have shown that even during sleep sufficiently deep to render the sleeper unconscious of any sounds, response to such sounds as are made by the early morning milkman is readily detectible. There are numerous practical difficulties in the quantitative measurement of noise, since acoustical, psychological, and physiological factors are all concerned. A general survey of the methods at present in use is given by Dr. Kaye. The results gathered from several independent sources deal with all types of noises, from the whispering human voice, the crying of twins, and the applause at Lindbergh's reception in New York, to transport noises, the roaring of lions, and the sounds of Niagara Falls.

IT is noteworthy that increased speed of transport is only obtained at the cost of increased noisiness, the average loudness levels in decibels above threshold inside various vehicles being for a recent type of bus or a saloon car or express train about 60, whilst for aeroplane cabins the value is about 100. Much of the noisiness of modern transport could only be reduced by redesign of the machinery involved, and it is unfortunate that the silence of the exhaust of the luxury motor car is obtained only by a certain loss of engine efficiency. For this reason, the same methods could not easily be used to reduce the machine-gun-like noises of the motor bicycle exhaust. The absolute amount of sound energy lost by even the noisiest of machinery is negligibly small, and quieter machinery is therefore only more efficient because of better mechanical design and not because of absence of sound-energy losses. From noise measurements made inside buildings, it is evident that stillness could be much more readily obtained in the Victorian home with its general solidarity, heavy hangings, and absence of loud speaker and gramophone, than in the modern ideal home with its thin walls and flimsy hangings.

ON Aug. 20 occurs the centenary of the birth of the eminent Austrian geologist Eduard Suess, who was born at No. 4 Duncan Terrace, Islington, a house which now, thanks to the action of Dr. F. A. Bather, bears a commemorative tablet. The son of a German merchant then resident in England, but who afterwards lived at Prague and Vienna, Suess was educated in the University of Vienna, and became an assistant in the Imperial Museum. At the age of twenty-six years he was made an extraordinary professor in the University, and ten years later was appointed to the chair of geology, a post he held until 1901. A most successful teacher, he counted among his pupils Mojsisovics, Fuchs, Waagen, Penck, and Neumayr, who became his son-in-law. In addition to his academic posts, he held seats in the Municipal Council of Vienna and the Diet of Lower Austria. It was largely through him that Vienna obtained an adequate water supply. He was chosen president of the Academy of Sciences of Vienna, was elected a foreign member of the Royal Society, and received the Copley Medal, while the Geological Society awarded him its Wollaston medal. He was included among the Scientific Worthies whose work has been reviewed in NATURE, an account of his life being given in our columns in 1905 by Sir Archibald Geikie. Suess died at Vienna on April 25, 1914.

MUCH of the earlier work of Suess dealt with the geology of the Vienna basin and the Alps, but he will always be remembered for his monumental work, "Das Antlitz der Erde". Setting himself the task of taking a comprehensive survey of all that had been accomplished in elucidating the geological structure of every part of the globe, he published the first part of his great book in 1885, the second in 1888, and the third in 1901. "The supreme scientific success attained by this great work", says von Zittel, "was a tribute to a work accomplished with the highest bibliographical skill and literary finish, the fullest geological and geographical knowledge, a convincing array of scientific facts that never fail to suggest an endless reserve in the background, and, above all, a calm, judicial, elevated tone of inquiry which the end of the nineteenth century may well feel proud to have witnessed and carried with it into its boasted wealth of scientific enlightenment." "Das Antlitz der Erde", it has been said, takes its place as a scientific classic beside Hutton's "Theory of the Earth" and Lyell's "Principles of Geology"; while of Suess, Prof. J. W. Gregory remarked, at the unveiling of the tablet in Islington, that "he ranked as the greatest original force in geological philosophy of his time".

ONE of the recommendations of the Committee on National Expenditure was the abolition of the Empire Marketing Board. The Board's report for 1930–31, which has recently been published (H.M. Stationery Office, price 1*s*.), forms an adequate comment on which we need not enlarge. In spite of the world-wide economic depression, record imports for sixteen commodities from the Empire into Great Britain have been established, the increase being attributed largely to the greater attention paid by the producers to grading and marketing and to the closer contact attained between the home traders and the overseas producers. Although its activities are developing considerably, the methods of the Board have been similar to those in previous years. Economic investigations and market inquiries have been extended, and grants for research work both in Great Britain and overseas are being continued. A complete list of the latter is appended, with a short account of the work under investigation in a number of cases. The importance of collecting and disseminating information regarding the supplies of Empire and foreign commodities available is fully recognised, and the issue of the weekly notes for fruit and dairy produce has been extended to include figures for the quantity of butter in cold storage, thus making a study of the consumption of imported butter possible for the first time. Two further reports on economic investigations, entitled respectively "The Marketing of Cheese" and "The Preparation of Fruit for Market", have been published, bringing the total number of this series up to twenty-five, and statistical surveys of world production and trade in beef and wool, similar to those already issued for oranges and cocoa, are nearing completion. Publicity has been obtained in a variety of ways, and definite success has attended the experiment of the opening of two shops in which samples of Empire produce are sold, under conditions which secure the goodwill and co-operation of the traders. The report concludes with a list of the publications of the Empire Marketing Board and the Imperial Economic Committee.

The use of electricity to heat the soil around plants so as to force their growth has been experimented with successfully by engineers connected with the Southern California Edison Company. The main factor to which the success of the experiment is due is that the product can be placed on the market early, so that the price is three or four times greater than later on. When all the crops mature at the same time, the market is flooded and the price falls. Two exactly similar plots of ground were taken. One had insulated wires running through it about four feet apart and at a depth of eight inches. The current in the wires was regulated by a thermostat so as to maintain a temperature of about 70° F. Current flowed on an average two hours out of every five. The other plot was not electrically heated but was prepared in exactly the same way. Cucumber seeds were planted in both plots, in rows about four feet apart. It was found that more than one half of the crop in the wired portion had matured and been marketed before the first cucumber had reached maturity in the unheated plot. The net revenue obtained from the electrically heated plot was about £20 greater than from the other. Details of the experiment are given in the *Electrical Review* for Aug. 7.

Marconi's Wireless Telegraph Co., Ltd., has acquired from the British Air Ministry the full rights and drawings for the design and erection of radio beacon stations of the rotating type. Marconi fixed beacon transmitters have been installed at important coastal points in many parts of the world as an aid to maritime navigation. The company will now be able to provide for aerial navigation as well. Both kinds of navigation will doubtless benefit by having alternative beacons. The experimental rotating beacon stations at Orfordness, Gosport, and Farnborough have been reported on favourably. A special feature of the rotating beacon system is that it requires only an ordinary radio receiver and a stop-watch to enable a ship or an aircraft to take its bearings. It is likely, therefore, that the system will prove valuable in extending the use of radio navigation even to quite small ships. The beacon makes use of a vertical closed aerial rotating at a uniform speed of one revolution in 60 seconds. The radiation from such a loop is a maximum in the plane of the loop, and zero, or a minimum, at right angles to that plane. For the calculation of bearings, two distinctive signals—a 'north signal' and an 'east signal'—are transmitted at regular intervals as the aerial rotates. The normal method of observation at the receiving station is to start a stop-watch at the moment the north signal ends, after which the time taken for the zero signal to be reached indicates the bearing of the observer from the beacon. If the observer is due north or south of the beacon, he may not be able to read the north signal, owing to the directional effect of the transmission. In this case the east signal is taken as the starting point. The number of seconds from the reception of the signal to the reception of the minimum signal gives the bearing in degrees. It seems likely that when navigators have become accustomed to radio beacons, it will be possible to dispense with several lightships.

Following on the excavation of a seven-roomed house, later converted into baths, at North Wharnborough, Hampshire, which was discovered in 1929, a building of considerable size has been brought to light, as is announced in the *Times* of Aug. 10, which may furnish much-needed evidence bearing on the rural organisation of Roman Britain. The buildings are situated only 8½ miles from the city of Calleva Atrebatum (Silchester); but they lie on no known Roman highway. The larger structure, like the smaller, would appear to have served two purposes; for at some time in its history it was converted by the erection of interior walls of wattle and plaster, relatively less substantial than the solid outer walls, into a system of cubicles, probably intended for farm labourers. Four buildings outside the south-west outer wall are probably stables. Coins, all belonging to the Constantine period or later (A.D. 306–381), were found. Presumably Silchester served as the market town for the villa. This is in some measure supported by the discovery of a potsherd inscribed 'Peregrini'. There were two potters of the name of Peregrinus, one from Southern Gaul, of the age of Domitian, A.D. 81–96, the maker of ware which has been found on several sites in Britain, and notably at Silchester.

The academic study of comparative law is, as a rule, confined to codified law. This is due in part to the fact that material for study of non-codified law has not been available. In the nineteenth century opportunities for collecting data were neglected, as it was considered inevitable that such systems were destined to disappear. The event has proved that this view was erroneous; at the present day one half the globe is under the jurisdiction of Oriental and tropical customary law. Further, juridical science is coming to recognise more and more the importance of the non-codified systems of law. The whole subject, however, is in need of organisation before systematic

(*Continued on p.* 265.)

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Noise and its Measurement.*

By Dr. G. W. C. KAYE, O.B.E., Superintendent, Physics Department, National Physical Laboratory.

FREQUENCY AND INTENSITY RANGES OF THE EAR.

AS is the case in many branches of science, the physics of acoustical research owes its present facility and exactitude largely to the development of electrical methods of measurement. The key lay in the invention of the electronic valve, and to this the subject owes an impetus which it had long needed.

Before we pass on to the question of noise measurement, we shall be well advised to review the relevant physical facts about the ear, which is of course the ultimate critic in matters of noise. The foundations of the subject rest largely on experiments with pure notes, and here it should be recognised how greatly our present knowledge of both hearing and speech is due to the noteworthy investigations of Dr. Harvey Fletcher and his colleagues at the Bell Telephone Laboratories in New York.

With reference to frequency, the average ear can perceive a range of frequencies from about 20 to 20,000 cycles per second, the upper limit declining with advancing years. In the various practical developments of acoustics, however, attention is largely restricted to the ranges 50 to about 5000 for speech, and 35 to 7000 for music.

As regards intensity, it has been shown by Wegel and others, from experiments on pure notes, that there is a certain minimum amplitude for each frequency below which the average ear fails to detect the note. Moreover, the ear is much more sensitive to notes of medium pitch than to higher or lower notes. The threshold or lower limit of intensity passes, in fact, through a minimum at about 2000 cycles per second as we steadily change the frequency.

Similarly, there is a maximum amplitude peculiar to each frequency, above which the ear no longer functions—hearing is subordinated to a tickling sensation or even actual pain. Again the ear shows to advantage in the middle of the range (about 500 cycles per second), and so the upper limit of intensity or threshold of feeling passes through a maximum as we progressively vary the frequency.

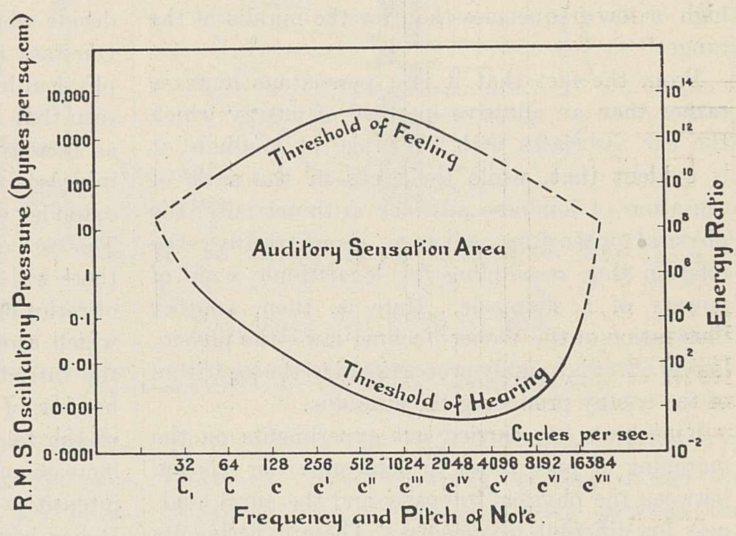

FIG. 1.—Average area of normal hearing, showing auditory ranges of frequency and intensity. (From Fletcher's "Speech and Hearing".)

Fig. 1 shows the auditory sensation area for the average ear as determined by Fletcher and Wegel. The boundaries are constituted by the two threshold curves, the dotted portions being those which are difficult to determine. We see that the range of audibility passes through a maximum (at about 1000 cycles per second) as the frequency is varied, and is greatly reduced towards each end of the musical scale. This maximum range corresponds to about a million million-fold variation in power,

* From a Friday Evening Discourse given at the Royal Institution on May 8.

or a million-fold variation of acoustical pressure from about, say, 0·0005 to 3000 dynes per sq. cm. We note also in the case of very high and very low notes the great intensity that is essential for audibility and how restricted the range of audibility is. A familiar illustration is the sound from a 32-ft. organ pipe, which one feels rather than hears.

The Matching and Masking of Sounds.

As regards the matching of sounds, it is found that the average ear can recognise under very favourable conditions a 10 per cent difference of energy when two pure notes of medium loudness are sounded alternately without break. This figure is more than doubled if there is an interval of silence between the two notes of so little as half a second. Under ordinary conditions, however, the smallest average change in energy level detectable by the normal ear is of the order of 26 per cent for sounds of medium intensity and frequency. The figure is greater for feeble sounds, and less for very loud sounds. The value is also greater for very high or low frequencies than for the middle of the range.

From the fact that it is a percentage increase rather than an additive increase of energy which the ear associates with a change of loudness, it is evident that, while the steps in the scale of sensation of loudness advance arithmetically, the physical intensities advance geometrically, the relation thus resembling the logarithmic scale of powers of a slide-rule. Here is, then, another illustration of the Weber-Fechner law—the physiological effect is roughly proportional to the logarithm of the energy producing the stimulus.

Kingsbury has carried out experiments on the matching of pure tones to determine the relation between the physical intensity and the aural loudness for different frequencies. These experiments indicate that for frequencies between about 700 cycles and 4000 cycles per second the relation between loudness and intensity is independent of the frequency. For notes of lower frequency the loudness increases proportionately more rapidly than the intensity. Kingsbury's results are set out in Fig. 2, which shows a number of equal loudness contours superposed on the auditory sensation area. As will be seen, these contours are roughly parallel to each other for medium frequencies above about 700 cycles per second.

An experimental illustration based on such loudness contours is to operate a pure sound at constant intensity, and gradually increase the frequency, when the loudness will be heard to pass through a maximum at about 2000 cycles per second. This is evidenced by the track of the horizontal line in Fig. 2 at a level of about 0·1 dyne per sq. cm.

The masking of one pure note by another is usually measured by the extent to which the threshold of audibility of the masked note is raised. In general, a particular note is masked (1) most readily of all by another of approximately the same frequency; (2) more readily by a note of lower frequency than one of higher, at any rate for loudnesses about and above speech level.

The position is not so simple with loud complex sounds such as noises, as the masking may be confused by other factors such as the masking of the individual components and the formation of subjective tones (see Fletcher's "Speech and Hearing").

The Decibel.

We are now aware of the area of auditory sensations which we have to measure, and we have to decide what is to be our 'yardstick' or 'degree'. Our task is to try to correlate aural loudness with physical intensity or energy; and already we have seen that while the sensation of loudness advances, as it were, by simple addition, the energy level increases by leaps and bounds on a scale which extends over almost astronomical magnitudes. This is a cumbersome relation, and it is clear that there will be a real convenience in adopting a scale of ratios of energy for our purpose. A similar need which arose in telephone engineering was met by the introduction of the 'bel', a name chosen in honour of Alexander Graham Bell, the inventor of the telephone. One 'bel' expresses a tenfold increase of power or energy; in other words, two intensities in the ratio $r : 1$ differ by ($\log r$) bels.* It has been generally agreed to adopt the bel for acoustic requirements also, or rather the 'decibel' (db.), since the bel is a little too large for the purpose. We thus have the following tabular relation:

Ratio (r) of Intensities.	No. of Decibels ($10 \log r$).
1	0
10	10
100	20
1,000	30
10,000	40
—	—
10^{13}	130

It will be realised that this scale of decibels is in no sense physiological but is based wholly on intensity

* Logarithms are to base 10.

as measured by physical methods. The scale has, however, the specific advantages (1) of being a rough fit with the aural scale of loudness sensation; (2) that experiment shows that the decibel, as above defined, corresponds approximately to the least perceptible change in loudness of a sound of medium loudness under average conditions. In actual fact, the loudness step in question is sometimes a little more and sometimes a little less than a decibel (ranging from 0·2 db. to 9 db.), according to the frequency and the location in the auditory sensation area.

We are now in a position to set up a definition of the sensation level of a pure note of specified frequency in physical terms. Our 'degree' will be the decibel, our 'zero' the threshold of audibility for that frequency, and the sensation level of a pure sound may accordingly be defined as the intensity in decibels above the threshold of audibility of that frequency.

On this basis experiment shows that, for pure sounds of medium frequency, the range of audibility between the thresholds of hearing and feeling is covered by about 130 decibels. This figure is rather less for high and low frequencies.

The position, however, is not so straightforward when we come to the broader question of comparing the loudness of pure sounds of different frequencies. We find at once that there is no simple relation of wide application between physical intensity and loudness. Two pure sounds of different frequencies do not in general produce the same loudness sensation, even if (*a*) their physical intensities are equal, or (*b*) their physical intensities bear the same ratio to their respective threshold values, that is, if the sounds have equal sensation levels. Further, if the intensity levels of two pure sounds of different frequencies which appear equally loud are increased by the same amount, the sounds will not in general remain equally loud.

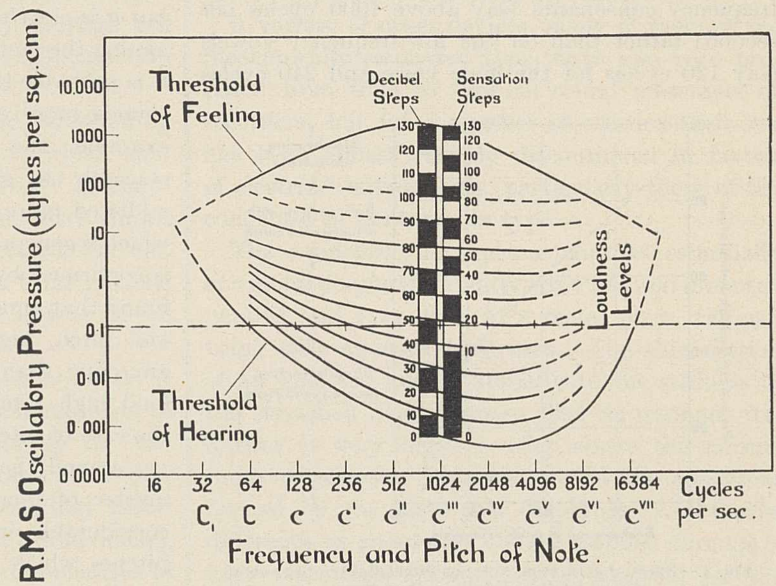

FIG. 2.—Auditory sensation area, showing equal loudness contours; also decibel 'ladder' and sensation-step 'ladder' for a frequency of 1000 cycles per sec.

It follows that, in the case of sounds of different or mixed frequencies, neither the physical intensity level nor the sensation level can be used as a measure of loudness. In the circumstances, we have to adopt an arbitrary scale as a practical standard, and a suitable one for the purpose is the sensation scale of a pure note having a frequency in the region of 1000 cycles per second. Then the loudness of any sound, whether pure, or a mixture such as noise, is defined as the sensation level (expressed in decibels above the threshold value) of the standard note which appears equally loud to the ear. It may be mentioned that the zero or threshold value of a 1000-cycle scale corresponds to a pressure of about 1 millidyne per sq. cm.

It should be reiterated that such a standard scale is quite arbitrary, and that equal increments on the scale do not in general approximate very closely to an equal number of sensation steps. For example, in the case of the 1000-cycle scale, the step from 0 to 10 decibels corresponds roughly to about 1 perceptible gradation of loudness under average conditions, the step from 50 to 60 contains about 10 gradations, and the step from 100 to 110 about 15. In other words, we may ascend the range of physical intensity lying between the two thresholds, either by the decibel ladder with equally spaced rungs, or by the sensation-step ladder with rungs first widely spaced and afterwards more narrowly though more evenly spaced (see Fig. 2).

It may be added that, in adopting a practical scale of loudness, some latitude is possible in the choice of the standard frequency, in view of the fact that for medium frequencies above 700 cycles per second there is a constant relation between loudness and sensation level. For example, the standard frequency chosen for much of the work at the National Physical Laboratory is 800 cycles, while, in the United States, 1000 cycles has been largely used.

Speech and Noise.

The masking effect of a background of noise on the ease of conversation is one of primary interest. Conversation begins to be difficult when the background of noise reaches 70-80 db., while at 90 db. conversation, even by shouting, is virtually impossible.

It should be remembered that the greater part of the energy of the human voice is in the low-frequency region. Some sixty per cent of the energy lies in frequencies below about 500 cycles per second, and about eighty-five per cent below 1000 cycles per second. It is known, however, that the intelligibility of speech rests largely on the high-frequency consonants (say above 1000 cycles per second) rather than on the low-frequency vowels (say 120 cycles for the male voice and 240 cycles

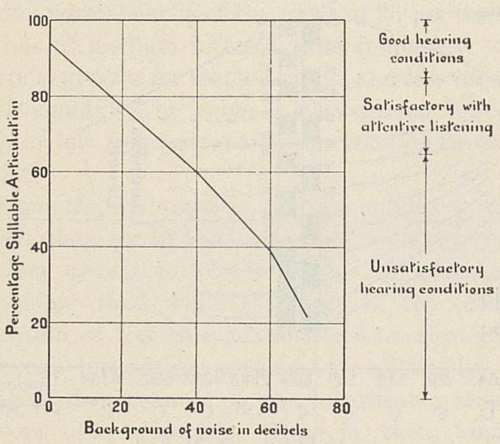

Fig. 3.—Effect of extraneous voice on intelligibility of speech of normal loudness (50 db.). (Knudsen.)

per second for the female), despite the fact that the low-frequency components carry the major part of the energy.

Davis and Evans at the National Physical Laboratory have observed that conversation in an enclosure is facilitated if high-pitched noises are excluded from without. It is fortunate that such notes can be more readily excluded than low notes, and particularly so where limits are set to the massiveness of the walls of the enclosure, as in an aeroplane cabin. Furthermore, such high notes as gain entrance are more readily absorbed by mounting absorbent on the inner walls.

As regards the effects of noise on the hearing of speech, Knudsen found in 1925 that, if the interfering sound is a pure note at about speech level, the interference with speech is almost independent of frequency, but that for greater intensities low-pitched notes interfere more than high. He also states that the interfering effect of noise is greater than that of a pure note whatever the pitch. Fig. 3 (due to Fleming) summarises Knudsen's results on the effect of extraneous noise on the intelligibility of speech as interpreted by articulation tests with speech of normal loudness (50 db.). As will be seen, even a little noise affects speech reception adversely, while a noise level of some 30-40 db. reduces the intelligibility by an intolerable amount.

Annoyance and Noise.

The association of annoyance and noise has recently been the subject of experiment. Precise measurement could scarcely be expected perhaps, but it is clear that both frequency and loudness are among the factors which play a part. As to pitch, it is probable that the majority of people find shrill sounds more offensive than low. They find, for example, the high-pitched motor horn, to the staccato use of which the Paris taxi-driver is so addicted, more irritating than the lower pitched horn which is generally used in England. This impression is confirmed by the work of Laird and Coye, who found that annoyance is a function of both loudness and pitch, high pitches being intrinsically more annoying than low or medium pitches, and very loud high pitches being especially irritating. In the case of pitches below about five hundred cycles per second the annoyance was, however, purely a matter of loudness. In this connexion it is of considerable interest to note that the range of pitches which man normally employs in his own speech appears to be the least annoying to him. The irritation produced by certain tenor and soprano voices is claimed by Laird and Coye as being in harmony with their findings.

The annoyance produced by complex noises such as those resulting from motor horns appears to be largely influenced not only by sheer loudness, but also by the presence of strong high-frequency components as well as by strong inharmonic components.

Absolute Measurement of Acoustical Energy.

A standard method of measuring the absolute energy of waves in general is to absorb them completely in some suitable material and measure the amount of heat generated. But, even if such absorption were possible in the case of sound waves, the absolute amounts of energy in speech and most other sounds of everyday experience are so small as to be on the borderline of the capacity of the most sensitive heat-measuring instruments we have. For example, the average speech power of the conversational voice is about ten microwatts. This value rises to about a thousand microwatts for the shouting voice, falls to 0·1 microwatt for the quietest speech, and to about 0·001 microwatt for the softest whisper. To take an illustration, a Final Cup-Tie crowd of 100,000 at Wembley Stadium all talking continuously and rather loudly would provide as much speech power as would, if converted, light a small electric lamp throughout the game. Alternatively, by the end of the match the acoustical energy expended would have been sufficient if transformed into heat, to boil enough water to make one cup of tea. An especially enthusiastic crowd which shouted vigorously all the time might similarly manage ten cups—perhaps enough to fill the Challenge Cup itself!

There are, however, one or two outstanding examples of acoustic disturbances in which substantial amounts of energy are involved. Measurements in New York on ships' sirens have shown a power-level of about 6 microwatts per sq. cm. at a distance of 115 feet, so that the total acoustic energy emitted by the siren would appear to be about $\frac{1}{3}$ h.p.

For sounds of ordinary magnitude, however, it is clear that the outlook for thermal methods of measuring acoustic energy absolutely is not promising, and we must turn to some other property of the sound waves. The oscillatory variation of the air pressure in the track of the advancing sound wave, the accompanying minute changes of refractive index and of temperature, the velocity of the oscillating air particles, and the radiation pressure exerted on a reflecting surface have all been employed. A conversational sound corresponds to an alternating pressure (*R.M.S.*) of about 1 dyne per sq. cm.,* in other words, to a pulsation of 1 millionth part of the atmospheric pressure. The change in refractive index for such a pressure variation is about one part in a thousand million, the temperature variation about 1/1000° C., the particle velocity of the air about 1/40 cm. per second, and the radiation pressure only some 10^{-11} of an atmosphere. The corresponding power is about 1/1000 microwatt per sq. cm., it being recalled that the power (or energy) varies as the square of the pressure and the amplitude.

For the purposes of absolute measurement, we are led to look for a measuring instrument which will give readings independent of both frequency and wave form of the sound. One of the most convenient is the Rayleigh disc, which measures the air or particle velocity. It is, however, a fragile instrument, to be regarded rather as an ultimate standard of reference, the use of which is necessarily restricted to the standardising laboratory. More convenient and robust instruments are essential for practical purposes, and recourse is usually had to electrical microphones, preferably of a non-resonant type. These translate acoustical oscillations into electrical oscillations which are amplified by a suitable valve amplifier, and so can be conveniently and accurately measured provided proper precautions are taken.

A variety of other devices, many of them of the mechanically resonated type, have also been proposed from time to time as sound measurers or recorders, but for a number of reasons their use has been almost entirely discontinued in favour of electrical microphones, particularly those of the condenser or electrostatic type.

The condenser microphone consists essentially of a metal diaphragm tightly stretched and mounted parallel and very close to a metal plate, the gap being only about 1/1000 inch. The thin section of air enclosed adds materially to the stiffness of the stretched diaphragm so that its resonant frequency is very high—usually above the normal range of acoustic frequencies. To the condenser formed by the plate and diaphragm a potential difference of about 200 volts is applied through a high resistance. Sound waves incident on the diaphragm cause it to vibrate, resulting in variations of the capacity of the condenser which, in turn, produce across the series resistance an alternating E.M.F. which can be readily valve-amplified and so measured by means of a rectifier (such as a thermojunction) and microammeter. Alternatively, the wave form may be examined by a cathode ray oscillograph. The condenser microphone, though somewhat insensitive, enjoys the advantage of a fairly uniform response over the acoustic range of frequencies, and thus provides a useful standard instrument, which can be calibrated in absolute units.

Measurement of Noise.

It was, I think, Lord Kelvin who said that once we find out how to measure a thing, we begin to learn something about it. As regards noise, however, it is evident that the question of its measure-

* It is estimated that the street noise of New York exerts an average pressure of about 5 dynes per sq. cm. and may even reach 20 dynes per sq. cm.

ment is one of some complexity, involving not only physics but also physiology and psychology. Nevertheless, so far as the physical aspect goes, it is clearly desirable that there should be a consensus of opinion on the choice of a system of physical quantities. They should be preferably of an absolute character, so as to assist, *inter alia* : (*a*) in translating vague aural judgments and comparisons into facts and figures ; (*b*) in elucidating the causes and characteristics of noises ; (*c*) in comparing the results of different investigators ; and (*d*) in setting up such arbitrary standards of noise as may be desired in the light of social, technical, or legal requirements.

The practical measurement of noise usually comprises one or more of the following operations :

(1) The physical measurement of the 'over-all' power or energy-content of the noise, the result being ultimately expressible in absolute units (for example, dynes or microwatts per sq. cm.).

(2) The physical analysis of the noise into its spectrum of frequency components (cycles per second). This is often most illuminating in tracking down the sources of individual components, particularly of machinery noises.

(3) The physical determination of the wave form of the noise, though this is often difficult to interpret and to utilise quantitatively, particularly if the noise is aperiodic.

(4) The aural measurement in some accepted unit of the loudness of the noise, or, in other words, the evaluation of the 'noisiness' as perceived by the ear—the physiological arbiter of noise.

Physical Measurement of Noise.

We have already discussed the measurement of sound energy by means of the condenser microphone and amplifier. The amplified current is connected either to a rectifier and microammeter (graduated in decibels if desired) for measurement purposes, or, alternatively, to a cathode ray oscillograph if it is desired to examine the wave form. In view of the fact that the microammeter readings are measures of physical intensity and not of loudness (owing to the selective sensitivity of the ear to pitch), a frequency-weighting network is sometimes interpolated in the circuit with the object of approximating the results more closely to the average aural interpretation. The weighting curve may conveniently be chosen for a loudness corresponding to that of a 1000 cycle-tone at 30-40 db. above the threshold of audibility.

If it is desired to analyse the noise, this may be effected by incorporating electrical tuning or band-pass filtering devices into the circuit and so determining, in turn, the amount of energy associated with individual components or bands of frequency. It is not always possible, however, by such means to get sharp selectiveness, but, in any event, we have to recognise that as yet our knowledge is not sufficiently general to enable us to correlate exactly the over-all loudness of a noise with the energy or loudness of its constituents.

Search-Tone Methods of Noise Analysis.

The question of the practical analysis of noises which are reasonably periodic has been much facilitated by the introduction of search-tone methods, which in general enable sound to be more conveniently analysed and with higher selectivity over a wide frequency range than is possible by the method of tuned circuits.

When search-tone methods are employed, the noise to be analysed is received in a microphone, the current of which is amplified and 'mixed' in a valve-rectifier or modulator with that of a pure search-tone of constant intensity and variable known frequency from a heterodyne oscillator. As a consequence, the modulated current contains not only the search-tone, but also the summation- and difference-tones formed from the search-tone and the various individual constituents of the noise. For example, if the frequency of the search-tone is S, and that of a particular constituent of the sound is C, the frequencies of the summation- and difference-tones so formed will be $(S+C)$ and $(S-C)$ respectively.

One way of revealing the existence of either of these tones is to apply the modulated current to a highly selective mechanical resonator, such as a steel bar capable of vibrating longitudinally. Thus, as the search frequency is varied continuously, the bar will begin to resonate whenever either $(S+C)$ or $(S-C)$ becomes equal to the natural frequency of the bar. As we know S, we can evaluate C ; and further, the degree of response of the bar, which is observed by suitable means, will give us a measure of the energy in the constituent in question. In practice, S may range from, say, 11,000 cycles to 16,000 cycles per second, while the natural frequency of the bar may well be of the order of 16,000 cycles per second for the summation-tone method and 11,000 for the difference-tone method.

Grützmacher uses, instead of a mechanical resonator, a low-pass filter arranged to transmit frequencies less than about 30 cycles per second. It follows that, in the great majority of cases, both the search-tone and all the summation-tones are ruled out, and only those difference-tones with frequencies less than 30 cycles per second will pass the filter and be recorded by an appropriate amplifier and detector. Thus, as the search frequency is continuously varied, the detector will only respond when the frequency is within 30 cycles per second of that of a constituent tone of the noise. The magnitude of the detector reading can be made to afford a measure of the intensity of the component in question. In the outfit at the National Physical Laboratory the frequency of the search-tone is varied from, say, 30 cycles to 10,000 cycles per second by the rotation of an air condenser through 180°.

Aural Measurement of Noise.

As we have already seen, if we are provided with a standard pure note of medium frequency (above 700 cycles per second) the loudness of which is variable at will over a range which has been calibrated by physical means, then we can evaluate by aural matching or equality the loudness of any other pure note or, in general, of any complex note. Alternatively, measurements may be made of the loudness of the standard note which is just masked or drowned by the sound to be measured. The standard note may be produced by an electric diaphragm buzzer (as in the Siemens-Barkhausen audiometer with a single frequency of about 800 cycles), a valve oscillator (for example, the Western Electric audiometer with a choice of eight frequencies), or a gramophone record (with pure or 'warbling' notes), together with a suitable attenuator, in each case.

With all the various types of audiometer, the reading is best approached by a series of progressive comparisons alternating on either side of the critical value. In general, experience indicates that most people find themselves able, after a little practice, to obtain fairly consistent results with even the simpler forms of audiometer, at any rate with noises which are more or less continuous. On the whole, masking results are easier to obtain than matching or equality values. In the United States, masking results are usually preferred, affording as they do a measure of the degree of 'deafening' or the raising of the threshold limit for the particular frequency or band of frequencies used.

Clicker Experiments on Noise Measurement.

In 1929 I made some rough experiments on noise measurement, by the aid of a flexed steel-strip 'clicker', such as is sometimes used by lecturers. The note of the clicker is high pitched and surprisingly penetrating, and can be heard in quiet surroundings nearly 1000 feet away. The masking range of audibility was determined under a variety of conditions. In an aeroplane cabin or near a pneumatic road breaker or a riveter the range shrinks to 2-3 ft., while near an aeroplane engine the range is only a few inches. On the somewhat doubtful assumption of the inverse square law, the clicker confirmed the fact that the interior of a tube train (75-80 db.) is appreciably louder than that of an express train travelling at about 60 m.p.h.—even in the corridor with some of the windows open (70 db.). It is, of course, common knowledge that it is difficult to converse and listen in a tube train, but not difficult in an ordinary train with the windows closed, particularly in a first-class carriage, with its more generous upholstery.

The cabin of an aeroplane in a cross-Channel flight was found to be at least a thousand times (30 db.) noisier than an express train, although the plywood cabin walls cut down the noise of the engine a hundred-fold (20 db.). The preference exercised by knowledgeable passengers for seats in the rear of the cabin rather than in the region of the side propellers was confirmed, there being some 10 decibels difference. It was found that the customary practice of aeroplane passengers of plugging their ears with cotton-wool resulted in a reduction of the noise experienced by about 10 decibels.

Tuning Fork Measurements of Noise.

A very convenient and portable means of measuring noise has been suggested and used by Davis * at the National Physical Laboratory. A tuning fork is struck in some convenient standard manner—against the heel of the boot will do quite well, and no unusual care is necessary. The fork is then held with the flat of the prong towards the opening of the ear and as close as possible without actually touching. The time of striking the fork is noted, and the interval of time is observed until the loudness falls to the level of the surrounding noise. If desired, the time interval before the note of the fork is masked by the noise can also be measured. The rate of decay of the fork is calibrated in decibels

* Nature, Jan. 11, 1930.

by a buzzer or other type of audiometer. As the decay of the loudness of a fork is practically logarithmic, the calibration curve of decibels against time is roughly linear. Readings are facilitated in practice if, as the fork is approaching the matching value, it is moved to and from the ear, so that its sound is alternately louder and softer than that of the noise.

A particular fork used by Davis had a frequency of 640 cycles per second. Its loudness when it was struck was about ninety db., and the rate of decay was about 1½ db. per second. Noises as high as 110 db. were measured by means of masking observations.

Davis has used the method for determining the loudness of a variety of noises over the range of hearing, and obtained results which, as will be seen from Table I., are in good agreement with audiometer measurements by American observers.

TABLE I.

LOUDNESS LEVELS OF VARIOUS NOISES.

TRAFFIC NOISES.

Source.	Distance.	Average Decibels above Threshold.	Observer.
Very busy traffic, New York	..	75	Free
Very busy traffic, London	..	70	Davis, N.P.L.
Busy traffic, New York	..	70	Free
,, London .	..	60	Davis, N.P.L.
Quiet street, New York	..	60	Free
,, London .	..	50	Davis, N.P.L.
Quiet residential street, New York	..	40	Free
Quiet suburban street, London	..	30	Davis, N.P.L.
Quiet suburban garden, London	..	20	,, ,,

ROAD TRANSPORT NOISES.

Source.	Distance.	Average Decibels above Threshold.	Observer.
British.			
Tram on very noisy rails	In street	90	Davis, N.P.L.
Tram or open bus top .	,,	70	,, ,,
Bus, recent type . .	Interior	50-60	Kaye, ,,
Motor car, quiet . .	In street	50	Davis, ,,
Saloon car, average 25 m.p.h.	Interior	40	,, ,,
Saloon car, average 35 m.p.h.	,,	60	,, ,,
Saloon car, quiet, 35 m.p.h.	,,	40	Kaye, ,,
American.			
N.Y. street car (tram) .	10-15 ft.	70-75	Galt
,, ,,	Interior	70	Parkinson
Motor lorry, average .	15-50 ft.	70	Galt
Motor car, average .	15-50 ft.	65	,,
,, quiet . .	15-50 ft.	50	,,
Horse vehicle, paved street	15-50 ft.	75	,,
Horse vehicle, asphalt street	15-50 ft.	60	,,
Horse trotting . .	15-50 ft.	60	,,
Motor horn (British) .	20 ft.	80	Davis, N.P.L.
Motor horn (N.Y.). Directed at microphone	23 ft.	70-100 (average 90)	Galt
Motor horn (N.Y.). In street	25-100 ft.	70	,,
Police whistle (N.Y.) .	15 ft.	80	,,
,, ,, .	15-75 ft.	75	,,

TRAIN NOISES.

Source.	Distance.	Average Decibels above Threshold.	Observer.
British.			
Express train . . .	12 ft.	100 (?)	Davis, N.P.L.
,, ,, 60 m.p.h.	In corridor, windows open	70	Kaye, ,,
Train, windows open .	Interior	60	,, ,,
,, windows shut .			
,, 3rd class	,,	55	Davis, ,,
,, 1st ,,		50	,, ,,
1st class sleeper .	,,	45-50	Kaye, ,,
Suburban electric train starting	..	70	Davis, ,,
Tube train (London) .	Interior	80	,, ,,
,, ,, .	,,	75-80	Kaye, ,,
American.			
Express (Limited) train	Interior Pullman car	60	Parkinson
Suburban train . .	Interior	65	,,
New York Subway, express	15-25 ft.	95	Galt
New York Subway, express	Interior	95	Parkinson
New York Subway, local	6-30 ft.	90	Galt
New York Elevated train	15-20 ft.	90	,,
,, ,,	Interior	75	Parkinson

In American Pullman Railway Car. (Parkinson.)

3 db. increase in noise for 10 m.p.h. increase in speed.
5 db. ,, ,, by opening window.
5 db. ,, ,, when passing another train.
10 db. ,, ,, in tunnel.
5 db. ,, ,, in corridor.
5-10 db. decrease ,, when berths are made up.

MISCELLANEOUS NOISES.

Source.	Distance.	Average Decibels above Threshold.	Observer.
General.			
Conversation . . .	..	40-60	Galt
Whispering . . .	5 ft.	10-40	Davis, N.P.L.
Applause N.Y. (Lindbergh)	In crowd	90	Fletcher
Restaurants (London) .	Interior	40-70	Davis, N.P.L.
Typists' room . .	..	70	..
Church bells . . .	1200 ft.	60	Galt
Thunder	1-3 miles	65	,,
Animals.			
Lion roaring (N.Y. Zoo)	18 ft.	85	Galt
Siberian tiger roaring .	7 ft.	80	,,
Bengal tiger snarling .	15 ft.	75	,,
Dog barking, in street .	20 ft.	65	,,

VERY LOUD NOISES.

Source.	Distance.	Average Decibels above Threshold.	Observer.
General.			
Riveting . . .	35 ft.	95	Galt
,, . . .	200 ft.	80	,,
Pneumatic drill . .	20 ft.	90	Davis, N.P.L.
Printing-press room .	..	90	..
Steamship siren . .	115 ft.	95	Galt
,, ,, . .	1500 ft.	60	,,
Steam pile driver . .	20-80 ft.	85	,,
Hammering, building .	100 ft.	75	,,
Niagara Falls . . .	Noisiest spot	85	Royce
Aeroplanes.			
Aeroplane engine . .	10 ft.	110	Davis, N.P.L.
,, ,, . .	18 ft.	115	Parkinson
Aeroplane cabins (various)	Interior	80-110	Davis, Evans } N.P.L.
Aeroplane cabin . .	,,	95	Parkinson
Three aeroplanes in flight	3000 ft.	60	Galt

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Free, *Jour. Acous. Soc. America*, 1930.
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Parkinson, *Jour. Acous. Soc. America*, 1930.

Relation between the Loudness Value and the Masking Value of Noises.

As the masking effect of a noise is dependent on its composition, theoretically it is, in general, not possible to associate the loudness value of a noise (as determined either physically or by aural matching) and the masking value as determined aurally by one or other of the available audiometers. As a practical fact, however, it would appear that, for most of the ordinary complex and fairly continuous noises of everyday life, the loudness value exceeds the masking by a fairly constant difference, which tends to increase somewhat for louder noises, or for those of an intermittent staccato character.

For normal street and interior noises, the New York Noise Commission found that, on the average, the loudness value exceeded the medium-frequency masking value by about 15 db. For a very loud noise (90 db.), such as the intense cheering of a large crowd, it would appear from the Commission's Report, "City Noise", that the two values differed by 20 db. Davis in his tuning fork experiments found a like difference for a loudness of 110 db. He also deduces an approximately linear relation between masking and matching values for moderately loud noises.

In the case of measurements of aeroplane propeller noises of very high intensity made for the Aeronautical Research Noise Sub-Committee by the National Physical Laboratory, the two values differed by about 20-30 db., though it will be realised that measurements under such conditions are necessarily somewhat rough.

Examples of Noise Measurement.

Some simple illustrations of the measurement of everyday noises may be of service.

The loudness of speech ranges between about 40 db. and 60 db., an ordinary conversational tone being about 50 db. If, however, the lips of an average speaker are within half an inch of the ear of a person with normal hearing, the latter will receive the speech at a level of about 100 db. An average motor horn sounded about twenty feet away illustrates a loudness of about 80 db. Twins crying together are only 3 decibels louder than one crying alone! Another way of increasing a noise by 3 db. is for the observer to move 30 per cent nearer (that is, when in the open air); movement of another 20 per cent nearer (that is, halving the distance) would give a total gain of 6 db.

Fig. 4 shows a kind of 'noise thermometer' of common noises ranging up to 100 db.—a level which is unlikely to be exceeded in everyday experience. Some broad general groupings of noises are indicated on the left. Above 50 db. the scale is differentiated as containing in general those noises which we should do well to endeavour to moderate so far as it may be practicable to do so, and we can perhaps regard this figure as a kind of 'temperate' level on our noise thermometer.

Table I. contains a collection of loudness levels (rounded to the nearest 5 db.) of various noises as determined in Great Britain by the National Physical Laboratory, and in the United States mainly by the New York Noise Commission (the figure for the medium frequency test note being selected). Certain points of general interest are discussed below:

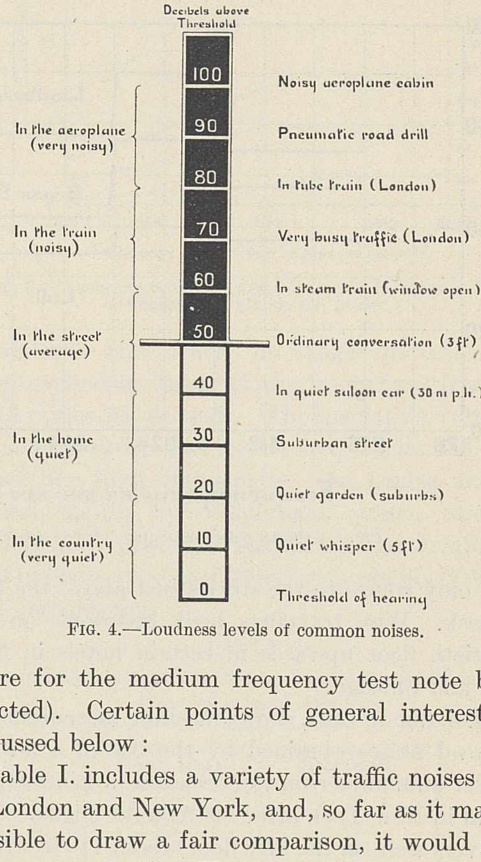

Fig. 4.—Loudness levels of common noises.

Table I. includes a variety of traffic noises both in London and New York, and, so far as it may be possible to draw a fair comparison, it would seem that a street in New York is on the average about 10 db. noisier than a like street in London. Although there are thoroughfares in London where at times a barking dog would not be heard 20 feet away, there are traffic centres in New York where, as the Commission has pointed out, a tiger could roar indefinitely without attracting the auditory attention of passers-by. It is stated that certain street corners in New York are normally noisier than anywhere so far discovered in the world; for example, the corner of Sixth Avenue and Thirty-fourth Street, which rejoices in three main streets, three tram-car lines, a double track line of the elevated railway, and the Subway (Underground). The arch sinner is the elevated railway, and nothing, I imagine, is less likely than that London will ever allow anything approximating to an overhead railway to override its streets.

The New York Commission found that the ebb and flow of noise from hour to hour closely parallels the density of the traffic, at any rate up to a figure of 50 vehicles per minute.

Some diminution of the traffic noise heard would naturally be expected in the higher stories of a building, but the effect is largely nullified if there are high buildings on both sides of the street. In such cases, even with 'sky-scrapers', appreciable relief only comes to the stories just above the first set-back. Wise travellers book bedrooms on the twentieth floor upwards in certain hotels in New York and Chicago.

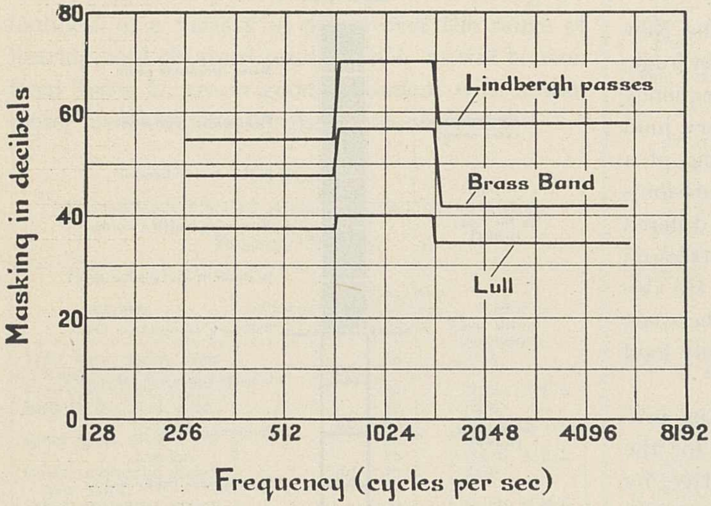

FIG. 5.—Crowd noises measured 110 feet away.

Fig. 5, due to Galt, shows masking measurements of crowd noises obtained by the use of a 3-band warbler audiometer on the occasion of Lindbergh's arrival in New York after his Atlantic flight. The observers were on the fifth floor, about 110 feet from the street. The masking effects of the noise produced by the crowd's welcome as Lindbergh passed are pronounced—quite sufficient, in fact, to mask the sound of a brass band not many yards distant. It is clear that here is a quantitative method, as Mr. Galt remarks, by which footlight and other favourites of the public can periodically assess their popularity.

As regards the individual components of traffic noise, it would seem from the limited data available that British and American tram-cars do not on the average differ appreciably as regards noise. The same remark probably holds for motor cars. It is of interest to note quantitative evidence that a modern car at moderate speeds is quieter than a horse vehicle on a paved street.

Among the contributory factors to traffic noise are motor horns, into the noisiness and stridency of which an inquiry of a restricted character was undertaken in 1929 by the National Physical Laboratory on behalf of the Ministry of Transport. Observations were made in a closed chamber with heavily lagged walls. Both physical and aural methods of measuring noise were employed, cathode ray oscillograph records being also made of the average wave form. It appeared from the limited observations that stridency was bound up largely with sheer loudness, but that strong high-frequency components, strong unrelated notes, and any marked starting characteristics were among the probable contributory factors. It was not found possible to correlate stridency with wave form.

The New York Noise Commission arrived at much the same conclusions. It considers that horns with sound levels in excess of about 90 db. when heard 23 feet away are unnecessary and objectionable. It finds that complaints of stridency are unlikely to arise when fundamental frequencies lie between 200 cycles and 300 cycles, when the overtones are all harmonics of the fundamental and share the energy evenly, and when there is an absence of strong high frequencies.

As regards trains, the noise levels of express and suburban trains in England and America seem to be not unlike for a similar class of accommodation. The American method of dividing up Pullman sleeping cars partly by means of heavy curtains seems, despite its other drawbacks, to result in a noise level comparable with that of our own more secluded first-class sleeping berths. In such circumstances, however, much depends on other factors, such as the good fitting of doors and windows, which restrict noise admission.

With reference to underground railways, the New York Subway stands in a class apart for noise—as anyone who has travelled by it will testify. London 'tubes' appear to be at least 10 db. quieter, though questions of speed may come in.

Among the loudest things one is likely to encounter are the noises of riveting, pneumatic road drilling, steamship sirens, and printing presses. More untoward events are lions and the Niagara Falls, which can apparently roar equally loudly (85 db.). But the arch offender is the aeroplane engine at close quarters (110 db.). The noise in the cabins of aeroplanes in flight ranges between 80 db. and 110 db., according to the type of machine. The noise of the propeller is probably the dominant factor, though engine exhaust and general engine clatter run it close, and all three must be seen to if an improvement is to be apparent. In the view of the Aeronautical Research Noise Sub-Committee, there are, however, good prospects that the noise in aeroplane cabins will presently be substantially reduced (possibly to that of a railway train) by using propellers with lower tip speeds, providing more effective silencers on the exhausts, reducing engine clatter by enclosing the engines, and constructing cabins of double walls containing a suitable filler.

Protection from Noise.

The best way of securing protection from noise is to quieten it at its source. This is much more effective than trying to control it later. For example, machines may be enclosed, or better balanced, or better shaped, and mounted on insulating materials.

As regards traffic noise, a great deal of the more objectionable noise is due to vehicles which are ill-cared for and in bad condition or badly loaded. Indiscriminate horn blowing is not, I think, a characteristic British trait. Where there is considerable traffic noise, much can be done to add to the comfort of a building by creating sound shadows, and by architectural ingenuity in providing ' buffer ' rooms, a recent example of which is afforded by the new headquarters of the British Broadcasting Corporation.

The protective shielding by buildings is well illustrated by the sylvan quietness of enclosed quadrangles, such as the Inns of Courts, which are in close proximity to noisy streets. The bedrooms opening on a hotel courtyard are usually much quieter than a room on the outside of the building, though sometimes the domestic quarters are so situated as to nullify the advantage.

There are two main practical methods for insulating an enclosure against air-borne noises: (*a*) By using single non-porous rigid walls or partitions. (*b*) By using multiple partitions as independent as possible and separated by air or some kind of loose filling.

In the case of the single rigid type of wall, the weight is the primary factor, the insulation value (in decibels) being proportional to the logarithm of the mass of the wall per square foot of area. Prisoners in the castle dungeons of old could not have been greatly troubled by air-borne sounds! Fig. 6 illustrates the measurements of Davis and Littler at the National Physical Laboratory. Their results, with those of Knudsen, the Bureau of

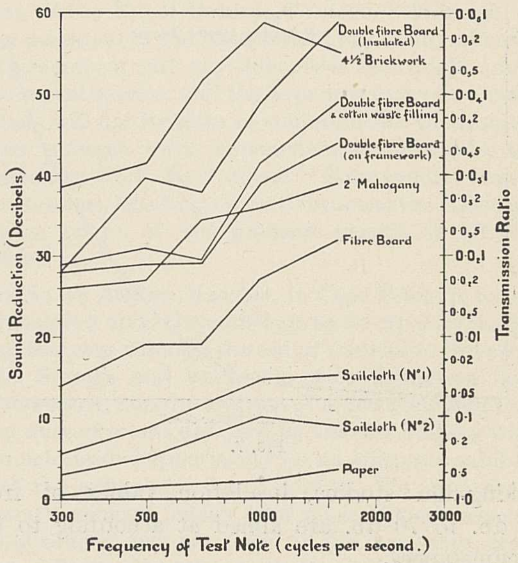

FIG. 6.—Insulating values of various materials for notes of different frequencies. (Davis and Littler.)

Standards and others on single partitions, are summarised in Table II. for a medium frequency (512 cycles per second). The insulation values are in general rather less for low frequencies and rather more for high frequencies. As panels transmit sound mainly by diaphragm action, resonance effects may come into operation at low frequencies, but under normal conditions are probably of secondary importance.

TABLE II.

SOUND INSULATION VALUES OF RIGID SINGLE PARTITIONS FOR AIR-BORNE SOUNDS.

Mass per sq. ft. of Wall Area.	Reduction of Sound in Decibels.
0·1 lb.	9
0·2	14
0·5	20
1	24
2	29
5	33
10	38
20	43
*40	48
60	51
100	54

* 4½ in. brick wall.

As a rough working rule, doubling the mass increases the insulation value by about five decibels, though resonance effects may spoil the relation.

In the case of porous flexible materials, Knudsen states that the insulating value is proportional to the mass of the wall per square foot of section rather than to its logarithm. Often a combination of the porous flexible material and the rigid dense partition is advantageous.

It may be here mentioned that for the stages of talking-film studios, insulation values of from 50 db. to 70 db. are aimed at according to the circumstances.

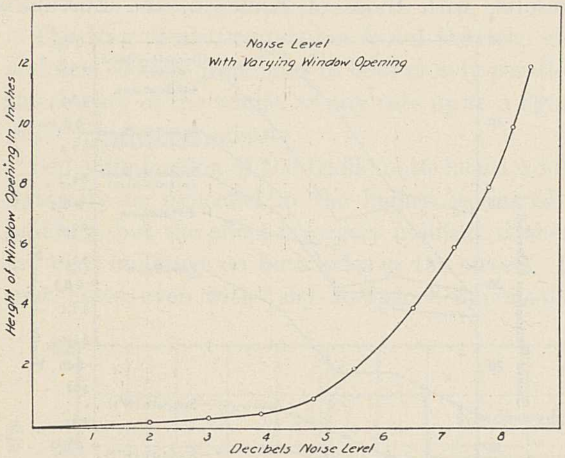

FIG. 7.

As regards multiple partitions, they should be wholly free of cross ties, that is, completely isolated from one another, if the combination is to be any better (as it may be) than one single partition of the same over-all thickness. Whether or not a loose filling material should be sandwiched between the panels is a matter for experiment, as such a filler may or may not be beneficial. On one hand, it may act as an absorbent and a damper of vibration, and on the other it may serve as a tie.

The question of protection from structure-borne noises is one to which it is hoped attention may be paid in the new Sound Laboratories which are to be erected at the National Physical Laboratory, as there is need for systematic experiment. Heterogeneity and discontinuity appear to be of value, and loose fillers may prevent the drumming of resonant panels or walls, which is often an accompaniment to such vibrations and may result in pronounced sound emission.

In many houses the windows are the chief offenders in admitting external noises. Sound-proof construction would be greatly simplified if windows could be abolished! This, of course, is not to be contemplated, but we can at any rate use substantial windows of thick glass. Opening a window even a little will, of course, largely nullify the benefit of noise shielding and absorbing devices. Within limits the amount of sound admitted by a crack or opening is proportional to its area. In the case of a door or window affording, say, 30 decibels insulation, a crack with an area 1/1000 of that of the door would admit as much sound as passes through the door or window.

Fig. 7 (due to Norris) shows the progressive increase in the noise level in a room when a window opening on to external noise was gradually opened. It will be noted that a small opening may produce a large effect.

Finally, considerable advantage may accrue in preventing noise which has gained entrance into a room from building up into a high level of reverberant sound by lining the walls and ceilings with absorbent materials. Certain banks and business houses in the City already employ the plan with advantage. I understand that many houses in New York line the roofs of their entrance porches with acoustic absorbent, deriving, it is stated, beneficial effects.

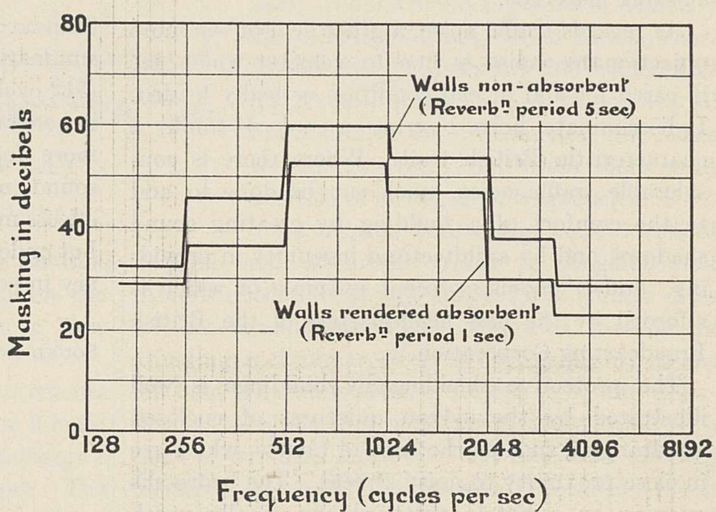

FIG. 8.—Room noises.

Fig. 8 (due to Galt) illustrates the effect on masking measurements in a room subjected to traffic noise of lining the walls with absorbent. As will be seen, the masking value was reduced by about seven decibels on the average, corresponding to a reduction in the reverberation period of from 5 sec. to 1 sec.

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study will become possible. We welcome an announcement which appears in *Man* for June that the Salle de Travail d'Ethnologie juridique of the Faculty of Law of the University of Paris is prepared to act provisionally as a central bureau for the study of customary Oriental and tropical law, and to serve as a channel of intercommunication between those who are interested in such studies. For this purpose, the subject has been divided into eight divisions according to geographical areas, and a beginning has been made by the printing of a dictionary of Indonesian law with the assistance of the International Academic Union. The study of Indonesian law will be further served by existing institutions, the Adat Law Section of the Royal Batavian Society of Arts and Sciences at Batavia, founded in 1926, and the Adat Law Foundation at Leyden, which was established in 1917. An inquiry is to be instituted in the Philippines in the current year.

At the ninth meeting of the Executive Council of the International Institute of African Languages and Cultures, held in Paris under the presidency of the chairman, Lord Lugard, on May 27–29, it was announced that the Rockefeller Foundation had promised a grant to the Institute, not to exceed £10,000 per annum, for a period of five years. Of this amount, £5000 per annum is a fixed grant. The remaining £5000 will be paid on the basis of £1 for each £2 obtained from other sources. The grant is for research work; and with this amount at its disposal the Institute will be enabled to prosecute a regular scheme of organised research, such as it has always contemplated since its foundation. A programme has already been discussed by the Executive Council. It is now being elaborated for submission at the next meeting of Council to be held in Paris in October. This generous recognition of the importance of the problems of Africa, of which the Rockefeller Foundation has shown itself convinced on previous occasions, should stimulate possible benefactors to ensure that the full amount of the grant may be made available for studies bearing upon what is held by many to be the gravest of the problems which will confront modern civilisation in the future—the relation of the white and the black races.

The sixth annual meeting of the British Association of Commercial Seed Analysts was held on July 25 at the National Institute of Agricultural Botany, Cambridge, the president, Mr. N. L. Dickson, being in the chair. The report of the past year showed that a considerable amount of work has been accomplished, particularly interesting results having been obtained by co-operative work among members in the testing of exceptionally difficult seeds. Six papers, including valuable notes on "New Crop Germinations", have been published and an exchange of papers made with various Colonial and American departments of agriculture and the American Seed Analysts' Association. All publications received have been added to the library and are available to members on loan; further, it is hoped to issue summaries of such papers, in addition to extracts from the *News Letter* (the official organ of the Association of Official Seed Analysts of North America). Papers on the question of the germination of damaged seeds, read by Mr. F. H. G. Neale and Mr. W. Hallam Harding, aroused considerable interest and tended to confirm the opinion that many so-called damaged seeds will eventually produce normal plants. It was announced that Dr. Nelson, of the Royal Botanic Gardens, Edinburgh, a former president of the Association, has kindly offered to help members with any difficulties that might arise with unusual species, and the hope was expressed that members will not hesitate to communicate the results of their research work, experiences, or difficulties to the secretary Mr. F. H. G. Neale, "Emmandee," Hawthorn Gardens, Reading, as by this means the Association can prove of the greatest benefit to all its members.

The South African Museum, in Cape Town, is to be congratulated upon the additions to its capacity made during the year through the aid of the Union Government. Storage and workroom accommodation has been increased, and the erection of a new wing and the taking over of rooms occupied by the Art Gallery will give much-needed opportunity for an adequate exhibition of the animals of South Africa. We trust that systematic zoology, which after all is but one aspect of a big subject, will not claim all the new space, and that a definite allocation may be made of room to illustrate the general teachings of natural science. Another side of the activities of this Museum deserves commendation. It sends annual expeditions to the country for the observation and collection of the native fauna, and in its journal, the *Annals of the South African Museum*, it publishes contributions to the knowledge of the animals of South Africa which, for quality and quantity, equal, and indeed exceed, the products of many much wealthier institutions. The abstract of accounts, which appears at the end of the Report for 1930, shows that the total grants made to the Museum fall short of £8000, and of this sum, more than £400 was devoted to the publishing of scientific results, evidence of the research enthusiasm of the staff.

The Imperial Bureau of Fruit Production, East Malling, Kent, has produced the first number of a journal, *Horticultural Abstracts*, that it is proposed to issue quarterly. The annual subscription, five shillings, is very reasonable, so that this publication may appeal to a number of horticulturists and students of horticulture. On the other hand, it is difficult to know where scientific work of a biological character definitely ceases to be of interest to horticulture, so that many workers will probably prefer the bigger and more expensive *Biological Abstracts* now issued by the Union of American Biological Societies, which includes a special section for abstracts of a definitely horticultural character. In the present number of the new journal, 108 papers are dealt with; the abstracts, whilst commendably brief, seem to give a very clear idea of the general character of the papers. It is certain, however, that four issues upon this scale will not cover comprehensively the annual output of general scientific work of interest to the worker in horticulture.

One important outcome of the Conference of Empire Surveyors in 1928 has been the foundation of the quarterly *Empire Survey Review*, of which the July issue is the first. It is published at 3*s*. a number by the Crown Agents for the Colonies. The issue opens with an article by Mr. O. G. S. Crawford on primitive English landmarks and maps, which traces some of the influences that led to the division of lands and the institution of boundaries up to the fifteenth and sixteenth centuries. Another article, by Capt. D. R. Martin, describes the ingenious map-mounting machine which for a few years has been used by the Ordnance Survey in place of hand mounting or of the use of linen-backed paper in the printing room. There are also several shorter articles on technical problems of survey, as well as reports on various Empire survey departments.

On Aug. 6, Mr. J. A. Mollison made a forced landing on English soil near Pevensey at 1.35 p.m., thus reducing the time for the flight between Australia and England by about two days. The actual time taken for the flight was 8 days 20 hours 19 minutes, the previous record, made by Mr. C. W. Anderson Scott, being 10 days 22 hours. The flight was an adventurous one, and Mr. Mollison experienced many difficulties, due chiefly to vagaries of the weather, which caused a certain amount of delay. The distance covered was about 10,000 miles, thus giving an average of about 1100 miles a day. The machine used was a Gipsy Moth, and, apart from extra petrol tanks, was a standard machine used for training amateur pilots. The engine was a Gipsy II. (120 h.p.).

It is with regret that we announce the death, on Aug. 6, of Prof. Archibald Barr, F.R.S., who was formerly Regius professor of civil engineering and mechanics in the University of Glasgow, and past president of the Royal Philosophical Society of Glasgow and of Section G of the British Association. Prof. Barr was seventy-six years of age.

The following appointments have recently been made by the Secretary of State for the Colonies: Mr. A. J. W. Hornby, agricultural chemist, Nyasaland, to be assistant director of agriculture, Nyasaland; Mr. A. C. Miles, provincial superintendent of agriculture, Gold Coast, to be assistant director of agriculture, Gold Coast; Mr. R. O. Williams, superintendent, Royal Botanic Gardens, Trinidad, to be economic botanist, Trinidad; Mr. G. F. Clay, senior agricultural officer, Uganda, to be deputy director of agriculture, Uganda.

It will be remembered that the Faraday Society has convened a Colloid Committee to organise periodical meetings for the discussion of subjects connected with colloid science. The first meeting was held in Cambridge last year to discuss "Colloid Science Applied to Biology". Arrangements are now on foot for the second meeting, which will be held in Manchester in the autumn of 1932 to discuss "Textile Materials, their Components and Related Topics". A special organising committee has been convened to draft the programme of the meeting.

The new edition of the "Guide to Current Official Statistics of the United Kingdom" (H.M. Stationery Office, 1*s*.) has now appeared. This annual volume is of value to all workers who have occasion to use any of the statistical reports of various Government departments. A glance at its pages shows the wealth of material available. The greater part of the 320 pages is a detailed subject index with references to the numbers of the publications, which are listed also in numerical order under the various departments.

We have received from Messrs. Watson and Sons (Electro-Medical), Ltd., Sunic House, 43-47 Parker Street, Kingsway, London, W.C.2, two new catalogues dealing respectively with diathermy apparatus and equipment for X-ray therapy. In each a brief introduction is given on the principles of the apparatus employed, followed by lists of outfits and accessories which experience has shown fulfil requirements. These include 'Sunic' condensers and spark gaps, induction coil apparatus, current generators, tubes and valves, filters and applicators, Greuz ray apparatus for treatment of skin affections, and protective materials.

Applications are invited for the following appointments, on or before the dates mentioned:—Two marine biologists (one a planktologist and one a benthos specialist) in the Marine Fisheries Laboratory of the Egyptian Government Coastguards and Fisheries Service, Alexandria—The Royal Egyptian Legation, 75 South Audley Street, W.1 (Aug. 20). A teacher of handicraft (woodwork, metalwork, and technical drawing), and an assistant master to teach, principally, elementary science and mathematics, at the Junior Technical School of the Castleford, Normanton, and District Mining and Technical Institute, Whitwood—M. G. Swaine, Education Offices, Castleford (Aug. 21). A graduate assistant at the Abertillery Mining and Technical Institute, and an engineering instructor at the Ebbw Vale Mining and Technical Institute—The Director of Mining Education, County Hall, Newport, Mon. (Aug. 24). A demonstrator of anatomy at the Royal Veterinary College—The Secretary, Royal Veterinary College, Camden Town, N.W.1 (Aug. 31). Two research assistants at the Institute of Agricultural Engineering, Oxford University, with special qualifications in, respectively, physics and engineering—The Secretary, Institute of Agricultural Engineering, 37a St. Giles, Oxford (Aug. 31). A male assistant curator of the Leeds Museums—The Committee Department, Town Clerk's Office, 26 Great George Street, Leeds (Sept. 9). A university reader in pathology at Westminster Hospital Medical School—The Academic Registrar, University of London, S.W.7 (Sept. 18). A William Julius Mickle fellow of the University of London—The Academic Registrar, University of London, South Kensington, S.W.7 (Sept. 30). A rector of Glasgow Academy—The Secretary, Glasgow Academy, 190 West George Street, Glasgow (Oct. 1). A Scottish medical secretary of the British Medical Association—The Medical Secretary, British Medical Association, Tavistock Square, W.C.1 (Oct. 1). A sixth form chemistry master at the Crypt School, Gloucester—The Headmaster, Crypt School, Gloucester.

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.*]

Velocity of Deep Currents in the South Atlantic.

In view of the great difficulty with which the speed of a deep current is measured, the following investigation is of considerable interest. The observations on which it is based were made by Mr. H. F. P. Herdman and me in the R.R.S. *Discovery II.* during the recent passage home from the Antarctic.

Vertical sections were made along the 30th meridian from 60° S. to 15° N. showing the distribution of temperature, salinity, oxygen, phosphate, nitrate, and nitrite content, and of the hydrogen-ion concentration. They show that the surface water found in the region of the West Wind Drift between 41° S. and 50° S. sinks rapidly below the surface along its convergence with the warmer sub-tropical water in 41° S. After sinking, it spreads northwards as a poorly saline layer between the depths of 500 and 1500 metres and covers the whole of the South Atlantic. It is then generally known as Antarctic Intermediate Water. As it sinks, it carries with it large quantities of dissolved oxygen, which are used up by the living animals and by the oxidisable matter in the water as it flows northwards. The accompanying table shows the depths of the minimum salinity values which represent the nucleus of the Antarctic intermediate layer, and also the oxygen content of the water in these depths, for different latitudes.

Latitude.	Depth of Minimum Salinity. Metres.	Oxygen Content in the Salinity Minimum. C.c./litre.
46° 42·5′ S.	330	6·02
43° 08′ S.	410	5·94
38° 10·5′ S.	800	5·45
34° 08′ S.	910	5·19
31° 16·25′ S.	940	4·86
26° 06·5′ S.	850	4·59
21° 13′ S.	850	4·24
15° 37′ S.	700	4·08
09° 47′ S.	750	3·50
03° 17·75′ S.	690	3·36
02° 59·25′ N.	740	3·06
08° 54·25′ N.	800	2·18
14° 27·25′ N.	800	2·37

Owing to differences in the temperature and the quantity of phytoplankton, the amount of dissolved oxygen in the surface of the West Wind Drift varies from season to season, and the amount which sinks and flows northwards must also vary. Fig. 1 shows the oxygen content of the Antarctic Intermediate Water plotted against latitude. It will be seen that the oxygen content decreases rapidly in the water as it flows northwards, but the points which represent the determinations lie on a curve which shows well-defined maxima and minima.

The water in the West Wind Drift has its maximum oxygen content in the spring, and the maxima on the curve represent the oxygen content in the water which has left the surface in successive years.

It is thus possible, by measuring the distance between two maxima on the curve, to find the distance the water has travelled in a year. The minima can be treated similarly.

Fig. 2 shows the velocities which have been calculated in this way. The circles represent velocities calculated from the maxima, and the crosses those calculated from the minima. The difference between

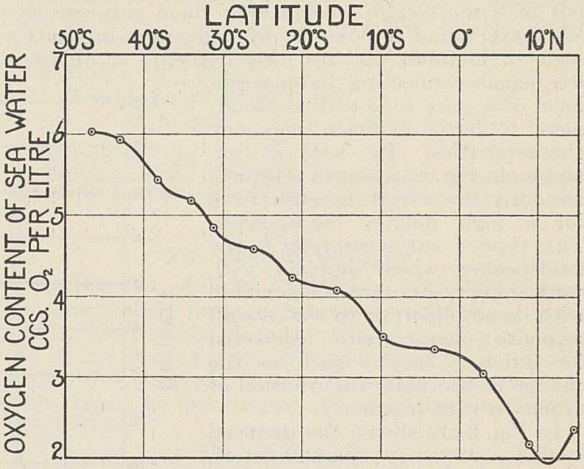

Fig. 1.—Variation of the oxygen content of the Antarctic Intermediate Water with latitude.

the two curves can be explained if the cold water which sinks in winter flows more quickly than the warmer water which sinks in summer. This might be the case owing to greater density of the cold water.

The conclusions reached are:

1. The stream of Antarctic Intermediate Water takes approximately five years to cover the 3300 miles between 40° S. and 15° N.

2. The northerly and principal component of its velocity increases from an average value of 1·2 miles per day in 40° S. to 2·5 miles per day in 7° S.

3. South of 20° S. there is a difference between the velocities of the water which sinks in winter and in summer.

4. The oxygen in the Antarctic Intermediate Water is used up between 40° S. and 10° N. at the rate of 1 c.c./litre in about 850 miles.

A similar method of investigation is being used to find the velocity of the North Atlantic Deep Current flowing southward at a depth of 2000–3000 metres.

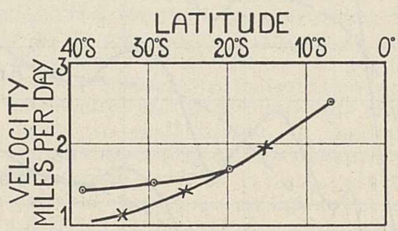

Fig. 2.—Variation in the velocity of the Antarctic Intermediate Current with latitude.

The curve of oxygen content is, however, affected by the influence of the Mid-Atlantic Ridge on the deep water movements, but a possible figure for the velocity of the deep current is 2·2 miles per day in 10° S.

This method of measuring current velocities in the Atlantic Ocean is described by Wattenberg [1] for the North Atlantic Deep Current, but no figures are given.

G. E. R. Deacon.

52 Queen Anne's Chambers,
London, S.W.1, June 29.

[1] Wattenberg, "Die Deutsche Atlantische Expedition, Gesammelte Expeditionberichte", 1925–27, p. 139.

Subjective Interpretation of Loudspeaker Frequency Response Curves in terms of Loudness.

In objective measurements of the overall response of sound reproducing systems, the need is continually felt of a method of interpreting them subjectively. We have found it possible, by utilising Kingsbury's scale of loudness and his measurements at different frequencies connecting the sensation level of a pure tone with its loudness,[1] to derive loudness-frequency characteristics. By way of example, in Fig. 1, is shown a typical measured acoustical response curve for a high quality loudspeaker. This type of curve can refer to the loudspeaker when supplied with constant current or when associated with its amplifier, or to the overall response characteristic corrected for different factors such as the change in the polar distribution of radiation with frequency.

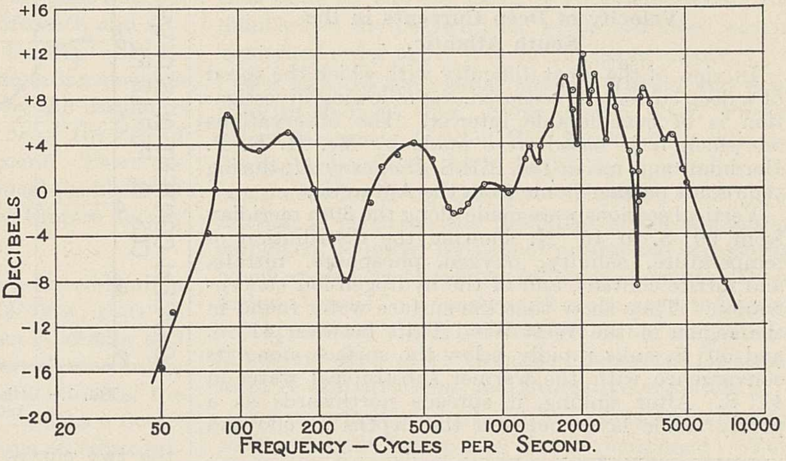

Fig. 1.—Typical acoustical response characteristic for a loudspeaker.

In Fig. 2 are shown the deduced loudness-frequency characteristics, corresponding to the objective curve in Fig. 1, for specified sound pressure levels at 1000 cycles per second (the frequency of zero level in Fig. 1), and these characteristics refer to the loudnesses of single pure tones when listened to in silent surroundings. The smooth chain curves passing through them refer to an ideal system in which the response is perfectly uniform at all frequencies. Departures of the actual loudness curves from these smooth curves give a measure of the frequency distortion of the apparatus in terms of loudness, and an observed variation in response in Fig. 1 is seen to cause a greater percentage change in loudness as the volume level of reproduction is decreased. Such curves as those shown in Fig. 2 are valuable as showing quantitatively how the apparent frequency range and tonal balance depend upon the absolute value of the sound pressure at the ear. The effect is analogous to the well-known change in tonal quality as one walks away from a band playing in the open air. The sound pressure at the ear is determined by either the distance from the source of sound or the overall characteristics of the electro-acoustical system. Solid models can be constructed from which the loudness may be read immediately at any frequency and sound pressure.

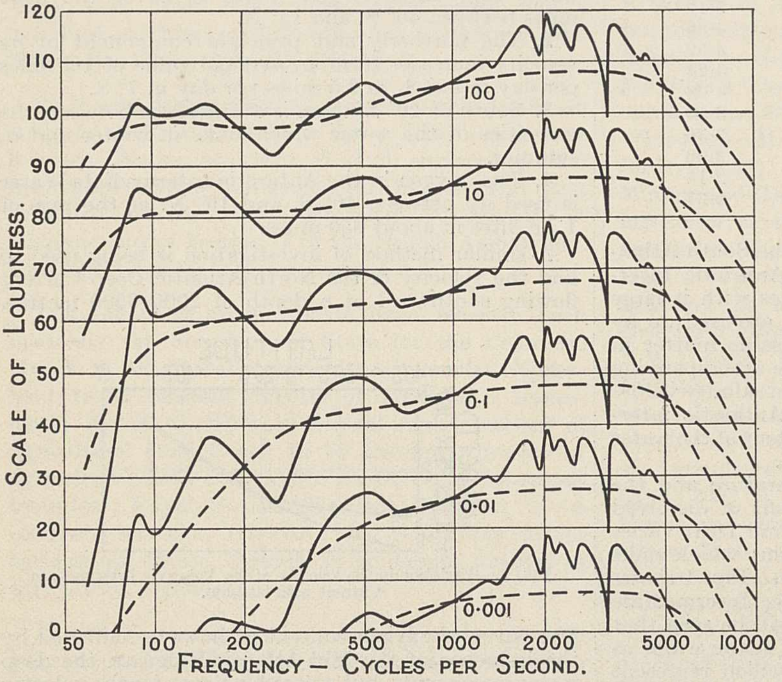

Fig. 2.—Loudness-frequency characteristics of objective characteristic in Fig. 1, at different sound pressure levels in dyne/cm.[2]

It is hoped to discuss some cases of technical interest at a later date.

D. A. Oliver.
Research Laboratories of the General Electric Company, Ltd., Wembley, July 15.

[1] Kingsbury, *Phys. Review*, **29**, 588; 1927. Also "Speech and Hearing", by H. Fletcher, p. 230. Fig. 108.

Classification for Bibliography of Science.

Mr. Bliss[1] has proposed the thesis, with which he is so good as to couple my name, that classification should be applied methodically to scientific literature and that the study of classification should now become a first concern of national and international organisations.

I am very glad to see that Mr. Bliss recognises the necessity for tackling the overwhelming output of scientific and technological writings. But I am not quite satisfied with his presentment of my case. I hope I am not doing him an injustice, but Mr. Bliss appears to be more interested in the perfection of the classification used than in the indexing of the literature, or, he seems to think that a perfectly logical classification is necessary for the preparation of a subject catalogue. But those who are working for the production of a comprehensive index to published scientific and technical information are inclined to look upon the classification adopted as merely a means to an end, and to criticise its comprehensiveness and flexibility rather than its philosophical basis.

In our view, the task of indexing the scientific and technical papers published throughout the world needs the employment of an army of bibliographers, the co-ordination of whose labours depends upon the use of the same classification. In such a way the International Catalogue of Scientific Literature was organised. On account of the many bibliographies of all kinds now in course of publication, we believe that general agreement by a number of bibliographers and bibliographical undertakings to adopt a standard classification would go a long way towards the immediate realisation of an extensive index to recorded information. We recommend the Universal Decimal Classification as being the only code, at present available, which is sufficiently comprehensive and minutely subdivided for the purpose.

I am sorry to be obliged to point out some small errors in Mr. Bliss's letter. The original Dewey classification was adopted by the International Bibliographical Conference (as the basis of an international bibliographical classification) in 1895, before, and not after, the issue of the report of the Committee of the International Catalogue of Scientific Literature.[2] Moreover, there is a large section for Biochemistry, termed Physiologic Chemistry, under 612.015, which is mentioned in the index to Dewey's decimal classification. It need scarcely be said that the subject is fully developed in the Universal classification. Further, I do not understand Mr. Bliss's objection to my use of the name "Universal Decimal Classification", which is the description on the title-page.

Mr. Bliss alleges that this classification is undeniably disqualified as being illogical and unscientific, for the reason that Science in Class 5 is separated from Philosophy in Class 1 and placed subsequent to Social Science in Class 3, which is remote from History in Class 9; that Philology in Class 4 is dissevered from Literature in Class 8, and so all the literatures from their languages; and further, that Biology and Psychology are not treated as distinct fundamental sciences but misrelated and dispersed. I am not quite clear as to the implication of the last sentence, but, as we are admittedly considering only scientific literature, I scarcely think that Mr. Bliss can claim that "These few examples [outside science] . . . justify . . . [the] criticism that . . . [the system] is disqualified and inadaptible".

In regard to Mr. Bliss's objection to the decimal notation, it may be said that, in practice, numbers are found to be quicker, and therefore cheaper, for filing than letters. It would be interesting to know how Mr. Bliss would classify a paper on "Relation entre les gradients du potential Newtonien sur un plan et son application à l'étude des anomalies gravifiques et magnétiques" according to his system.

Mr. Bliss goes on to say that he thinks that it would not pay to standardise an arbitrary classification for scientific bibliography, and proposes the co-operative development and standardisation of a basic classification and notation, consistent with accepted principles and with the organisation of science. No doubt librarians would be delighted to possess a classification which should be perfectly logical and consistent with accepted philosophical principles. But does Mr. Bliss really imagine that general agreement on the logical arrangement of even the main classes of knowledge could ever be attained? Every expert regards his subject as that in relation to which all others should be arranged, and no two experts would agree. Even if the best compromise were eventually accepted, the progress of discovery would render it obsolete in a day.

In the meantime, we have in the Universal Decimal Classification a bibliographical tool which has gradually been elaborated and improved by the collaboration of many hundreds of experts in the light of a quarter of a century of experience. Somewhat illogical in parts as it admittedly is, in practice, it proves to be adequate for the indexing of scientific and technical literature on the largest scale. Its use is extending day by day, and, with its aid, the 'subject index illusion' is being realised. S. C. BRADFORD.

8 Merton Hall Road,
Wimbledon, S.W.19,
July 22.

[1] NATURE, 127, 889, June 13, 1931.
[2] Pollard, A. F. C., "The Decimal Bibliographical Classification of the Institut International de Bibliographie", 1926, p. 3.

The Velocity of Light.

IN NATURE of June 13, 1931, p. 892, Mr. Gheury de Bray brings forward two new possibilities for the explanation of the decrease of the velocity of light. As in my opinion both of these possibilities lead to difficulties, perhaps I may be permitted, in view of the importance of the subject, to offer some comments upon them.

The first possibility is in contradiction to the supposition on which at one time the elastic theory of the light of material ether was built up. I am thinking of the equation $c=\sqrt{N/\rho}$ (Fresnel, Neumann), where c stands for the velocity of light; N, rigidity; and ρ, density of the ether.

As regards the second possibility mentioned in the explanation, that is, the idea of the increase of the distance of the two points in the course of time, the matter is a little difficult, as Mr. Gheury de Bray has not explained it in detail or mathematically, and without a mathematical deduction one cannot clearly gather what he really means. For this reason, I may be permitted to add to the idea of Mr. Gheury de Bray as much as seems necessary in order to explain my calculations.

The velocity of light is determined by the equation $c=s/t$, whereby s is the distance which the light has travelled, and t the time which the light has taken to travel such distance. Let us say that s is the distance of these two 'stable' points (base of measurement), which we required fifty years ago to measure the velocity of light. Let us suppose that this distance is to-day essentially greater; but we cannot ascertain this, as the metre also is increased in the same proportion, so that we shall, in determining the basis, obtain the same measurable numbers as fifty years ago. If the velocity of light (if we can at all express ourselves to-day in previous measurements) has not changed essentially, and if not one unit of time has changed, then we shall to-day, in measuring the velocity of light according to the distance s, obtain another measurable number $c_1=s/t_1$, which is less than the previous one ($c_1<c$) as light now requires a longer time ($t_1>t$) to travel the materially greater distance s, which only by its measurable number appears equal to that of fifty years ago. The decrease of the velocity of light would in this case only be apparent.

It can be gathered from the hypothesis which I have outlined in the foregoing, that the right measure for the distance of the two points would be the time which the light needs to travel the same. If, for example, all distances have increased in the proportion $1:(1+\epsilon)$, then t_1 is $=t(1+\epsilon)$; if we designate $c_1=c-\Delta c$, whereby Δc is apparently a decrease in the velocity of light, then the equation $c_1=s/t_1$ becomes

$$c-\Delta c=s/t\,(1+\epsilon)=c\,(1-\epsilon),$$

and is therefore $\epsilon=\Delta c/c$. By substitution of the value $\Delta c = 2 \times 10^7$ cm./sec. and $c = 3 \times 10^{10}$ cm./sec., the result is $\epsilon = 6{\cdot}7 \times 10^{-4}$. This means that all distances in the last fifty years would have to be increased in the proportion of 1 : 1·00067.

One would have to enlarge in the same proportion the distance of the planets from the sun, and the reciprocal distance between double stars. Let us suppose that the masses of celestial bodies are not altered in space through this increase, and also that the constant of gravitation is not changed thereby with regard to former units of measure, then the period of revolution, T, of each planet and of each double star would have had to change in the last fifty years to T_1 according to the third law of Kepler:

$$T_1^2 : T^2 = 1{\cdot}00067^3 : 1^3,$$

and from this we can calculate that $T_1 - T = T/1000$. This, for example, means that the time which the earth takes to revolve around the sun would have been increased in the last fifty years by 1/3 day!

I must emphasise that, in spite of all these difficulties, the suggestion of the aforesaid hypothesis by Gheury de Bray has its scientific value. It is necessary that all possible explanations be brought forth, in order to illuminate this question from all sides, but it is also the task of science to find out, after a critical examination, which interpretation is the most probable.

I stated last year that the decrease in the velocity of light, if this exists, is not in contradiction with the theory of relativity, and that, therefore, one could interpret this eventual decrease in accordance with this theory, that is, with the changes in time of g_{hk}. The change in the velocity of light would in this case be real. If the expansion of the universe is the cause of the decrease in the velocity of light, then this would mean that this is an actual case of the so-called λ-effect of the general theory of relativity, as one should, according to de Sitter, consider the expansion of the universe as such an effect of this same theory.

V. S. VRKLJAN.

Žerjavićeva ul. 16, Zagreb,
June 26.

The Bottle-Pipe Resonator.

IN the issue of NATURE of Aug. 30, 1924 (p. 309), Aldis gave a formula for a resonator consisting of a closed cylindrical pipe of large diameter (length L) connected to an open cylindrical pipe of smaller diameter (length l) which he termed a 'bottle-pipe', namely, $\tan(2\pi l/\lambda).\tan(2\pi L/\lambda) = S_a/S_D$ where S_a and S_D are the sectional areas of the smaller and larger pipes respectively and λ is the wave-length of the natural frequency. The accuracy of the formula was questioned in a later number.

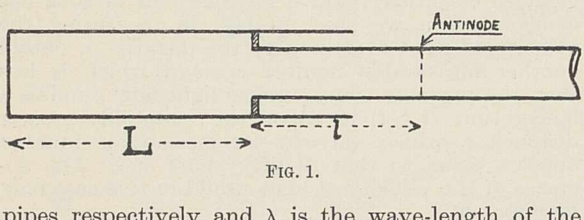

FIG. 1.

I have recently been experimenting on such a bottle-pipe resonator. To sound the resonator and eliminate the end-correction, I attached this resonator to the end of an open organ pipe, of which the diameter was equal to the diameter of the smaller portion of the resonator. The resonator was then adjusted until the system spoke at the original natural frequency of the pipe. The antinode at the end of the open organ pipe thus becomes an antinode of the open end of the bottle-pipe resonator, and the corresponding end-corrections of the pipe and the resonator are, therefore, eliminated (Fig. 1).

The method of blowing the pipe at the proper pressure and the determination of the position of the nodes in the pipe were as described in my papers in the *Phil. Mag.*, November 1929 and October 1930.

The experiment was repeated with varying lengths of the two sections (L and l) of the bottle-pipe resonator, and the results are shown on the accompanying curves (Fig. 2). The dotted curve gives the relation between the total length ($L + l$) of the resonator and the length L of the bottle section, for a frequency of 260 cycles per second. The full curve gives the relation between the two sections of the resonator; it is symmetrical about the axes, which is to be expected from the reciprocal nature of the formula.

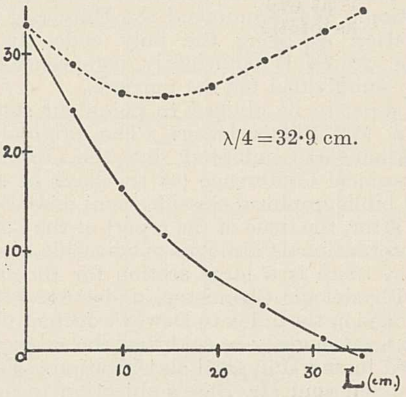

FIG. 2.

It will be seen that the ordinate of the dotted curve passes through a minimum value when the two sections of the resonator are of equal length, that is, $L = l$. In my case, these were found to be 12·9 cm., both practically and by calculation. Further, it will be seen that the relationship remains true even when the bottle section is indefinitely shortened.

I hope to publish shortly the full account of the experiments.

A. E. BATE.

The Northern Polytechnic,
Holloway, London, N.7,
July 10.

Absorption Spectra of the Ce^{+++} Ion in Solution.

THE experiments of J. Becquerel and W. J. de Haas [1] on the paramagnetic rotation of the plane of polarisation of light in a crystal of tysonite (which is a fluoride of cerium and lanthanum) has created an interest in the absorption spectra due to the Ce^{+++} ion. These authors, as a result of their measurements at low temperatures, and on the assumption that the dispersion produced in tysonite is due to the presence of a single absorption band, came to the conclusions that (i.) the rotation phenomena are due to the presence of the Ce^{+++} ion, and (ii.) the position of the absorption band is somewhere in the region of 2370 A.

Gibbs and White,[2] in their study of the relations between the doublets of stripped atoms in the different periods of the periodic table, found in the spark spectra of cerium a doublet with wave-lengths 2779·1 A. and 2457·6 A., which they attributed to Ce^{iv} corresponding to the transitions $6\,^2S_1 - 6\,^2P_{1,2}$ with $\Delta\nu(^2P_1 - {}^2P_2) = 4707$ cm.$^{-1}$. The nearness in the values of the calculated wave-length of the absorption band in tysonite and that of one of the lines of the doublet attributed to Ce^{+++}, made it appear worth while to investigate the absorption spectra of the Ce^{+++} ion in solution. For this purpose we prepared cerium chloride ($CeCl_3$) from chemically pure cerium nitrate. In solution it is known that the Cl^- ion shows absorption for wave-lengths < 200mμ, and therefore the region where the absorption due to the Ce^{+++} ion was expected would not be masked by the presence of the Cl^- ion. As a result of our investigations, we found two regions of selective absorption, which appear fairly narrow in width and of measurable intensities at two different dilutions. In the following table their positions are given, with the dilutions at which they appear most distinct. The wave-lengths of the emission doublet attributed to Ce^{+++} ion is also given.

Dilution.	Absorption wave-length.	Emission wave-length.
1/40 mol.	2960 A.	2779 A.
1/1000 mol.	2550 A.	2457 A.
	$\Delta\nu = 5432$ cm.$^{-1}$	4707 cm.$^{-1}$

It appears that the agreement between the two sets of values are as good as can be expected under the given conditions. The absorption lines are shifted towards the longer wave-length side. From magnetic measurements made on cerium salts, both in the solid state and in solution, it is known that the Ce^{+++} ion is in the $4\,^2F_{\frac{5}{2}}$ state corresponding to the following electronic distribution:

$$\begin{matrix} 4f & 5s & 5p \\ 1 & 2 & 6 \end{matrix}$$

By light absorption the $4f$ electron is raised to the $5d$ level, giving rise to $5\,^2D_{\frac{3}{2},\frac{5}{2}}$ terms. The calculated relative intensities of the doublet lines due to the transitions $4\,^2F_{\frac{5}{2}} \rightarrow 5\,^2D_{\frac{3}{2},\frac{5}{2}}$ is 14 : 1.

The result of our observation is compatible with the predicted ratio of intensities, if it is assumed that the $^2D_{\frac{3}{2}}$ term represents the higher energy level. The shift of the absorption band towards the longer wave-length side can be explained as due to the work done on the radiating electron by the surrounding dipole water molecules, when it is shifted from the inner $4f$ orbit to the outer $5d$ one, on the periphery of the Ce^{+++} ion.

D. M. BOSE.
S. DATTA.

University College of Science,
Calcutta, June 8.

[1] *Zeit. für Phys.*, **57**, p. 11; 1929.
[2] *Phys. Rev.*, **33**, p. 157; 1929.

Band Spectrum of the Green Flame of Phosphorus.

I HAVE made several unsuccessful attempts within the last two years to obtain a satisfactory photograph of the band spectrum of the green flame obtained when hydrogen containing a little phosphorus vapour is burnt in the air. The difficulty has mainly been that photographic plates are very insensitive in the green and the flame is not easily maintained for long periods.

I have recently obtained a good photograph, giving an exposure of 100 hours, using a two prism glass spectrograph giving a dispersion of about 10 A. per mm. in the green. In the most intense bands there is considerable overlapping, but a fainter band at λ 5066 comes out clearly, and Fig. 1 is a reproduction of a register of the band made for me very kindly by Dr. Baker, of the Royal Observatory, Edinburgh. The appearance is very like that of an infra-red vibration-rotation spectrum, but might be an electronic band in which the moment of inertia of the molecule in the excited and unexcited condition is very nearly the same.

The separation of the bands is about 14·4 cm.$^{-1}$ on the blue side of the gap and 18 cm.$^{-1}$ on the red side. The frequency differences between the gaps in the strongest two pairs of bands are 1187 cm.$^{-1}$ and

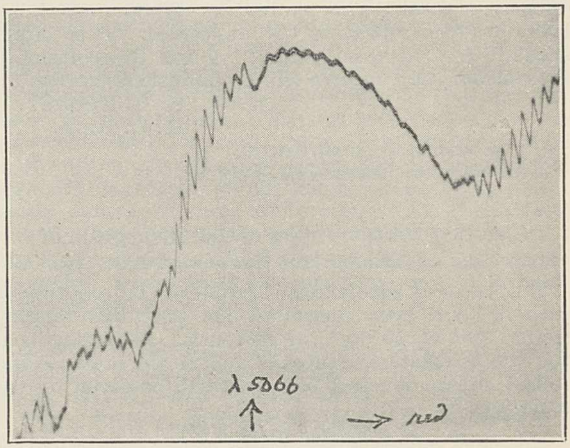

FIG. 1.

1306 m.$^{-1}$, but these measurements are only rough at present and the analysis of the whole system has not yet been made. The moment of inertia calculated from the value 14·4 cm.$^{-1}$ is $3·95 \times 10^{-40}$, which is not conclusive but suggests that the emitting molecule is more likely to be a hydride than the P_2 molecule.

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Ultra-Violet Absorption Spectra of Cyanogen and the Cyanogen Halides.

WE have photographed the absorption spectra of cyanogen chloride, bromide, and iodide, and cyanogen itself in the gaseous state. The light source was a water-cooled quartz hydrogen tube consuming 0·5 amp. at 10,000 volts, from which the emission was perfectly continuous up to the short wave-length limit of the spectrograph (1840 A.).

Cyanogen chloride (pressure, 760 mm.) and cyanogen bromide (pressure, 76 mm.) showed continuous absorption, beginning about 2240 A. and 2540 A. respectively, and extending in each case to 1840 A. Cyanogen iodide at room temperature has a continuous absorption with long wave-length limit about 2150 A. At higher temperatures (100° – 125° C.) another region of continuous absorption appears with a maximum of 2500 A. and long wave-length limit at 3100 A.

The most probable mechanism for the photo-dissociation seems to be

$$CN.X + h\nu \rightarrow CN' + X$$

where CN′ has the excitation energy 41 kcal. in all cases except the far ultra-violet absorption of cyanogen iodide, where CN′ has 73 kcal. excitation energy. This leads to values 86, 71, and 51–59 kcal. for the heats of dissociation of cyanogen chloride, bromide, and iodide respectively into CN and halogen atom. These values are each about 10 kcal. greater than the mean values given by Eucken for the carbon-halogen linkages in aliphatic compounds.

The absorption spectrum of cyanogen is discontinuous. Between 2380 A. and 1860 A. there are about forty bands, shaded towards the red. Some of these show rotation structure. The bands do not converge before 1850 A. (154 kcal.); the heat of dissociation of $(CN)_2$ into 2CN must therefore be greater than 81 kcal., if the dissociation at the convergence limit leads to CN and CN′ (73 kcal.). The heat of dissociation calculated from thermochemical data is 66 kcal. The photo-dissociation may, however, produce vibrating CN molecules. This would account for the discrepancy. A full description of these absorption spectra will be published shortly.

R. B. MOONEY.
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The Critical Increment of the Adsorption of Hydrogen on Amorphous Carbon at 400° – 520° C.

THE rates of adsorption of hydrogen on amorphous carbon have been measured for pressures ranging from 1 cm. to 10^{-3} cm. of mercury. Assuming that the rate of reaction is proportional to the pressure and to the surface covered, the rates will be given by the equation

$$-dp/dt = k(Ap + p^2)$$

where k is the velocity constant and A is a constant containing the area. This equation holds for the whole range of pressures and temperatures investigated, but A is not independent of temperature; it practically doubles as the temperature is increased from 400° to 520° C. The values of log k plotted against $1/T$ give a straight line, and from the slope a critical increment of 30,000 cal. is calculated.

If the reaction be written,

$$(1)\ 2C_s + H_2 = 2C-H,$$

and Mecke's values for the C – C, C – H, and H – H linkings be adopted, namely, 65, 90, and 101 kcal., the reaction is exothermic to the extent of 14 kcal., and if the carbon surface be activated, the heat of reaction will be larger. It is doubtful if the reaction actually occurs in this way, for the adsorbed gas is evolved as hydrogen on evacuating under a high vacuum at 800° – 900° C., whereas if the hydrogen had combined with the carbon, some methane would be expected. There is thus no evidence that the hydrogen has entered into chemical combination with the surface. It is possible, however, that the hydrogen molecules are dissociated into atoms by the process,

$$(2)\ 2C- + H_2 = 2C_s + 2H,$$

which is endothermic to the extent of 30–35 kcal., which corresponds with the observed critical increment. The result of the change is a deactivation of the surface with the production of adsorbed hydrogen atoms. On desorption, however, the surface returns to its original activity, so that if the above process occurs, it must be reversible.

The adsorption of hydrogen on carbon at 450° C. resembles that found previously for the adsorption of hydrogen and carbon monoxide on $ZnO - Cr_2O_3$ at room temperature,[1] and for the adsorption of hydrogen on manganese dioxide at 400° C.[2] It is unlike that of oxygen on carbon at room temperatures, for in this case the oxygen can only be removed from the surface in combination with carbon, and it is different from that of hydrogen and carbon monoxide on $ZnO - Cr_2O_3$ at 100° C., for these gases remove oxygen atoms from the surface on desorption. The adsorption of hydrogen on carbon appears to be of a type intermediate between van der Waals' adsorption and true chemisorption.

The main difficulty in the acceptance of equation (2) lies in the fact that carbon monoxide also gives rise to the intermediate type on oxide catalysts, where dissociation into atoms is not possible.

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[1] Garner and Kingman, NATURE, Sept. 6, 1930; *Far. Soc.*, **27**, 322; 1931.
[2] H. S. Taylor and Williamson, *J.A.C.S.*, **53**, 2168; 1931.

Intensity of Raman Scattering in Gases.

USING the apparatus described in earlier notes in NATURE, it has been found possible to estimate by photographic photometry the intensities of the Raman lines given by various simple gases and to make a quantitative test of the theory put forward by Manneback.[1] The results, on the whole, seem to be favourable to the theory. The intensities of the rotational Raman lines representing the 0→1, 1→3, 2→4, and 3→5 quantum transitions in hydrogen gas are respectively in the ratio 1 : 3 : 0·4 : 0·2, Manneback's values being 1 : 2·8 : 0·35 : 0·19. His theory further enables us to express the absolute intensities of these lines as fractions of the undisplaced Rayleigh lines if the optical anisotropy of the molecule is known. This may be computed from the observed depolarisation of the Rayleigh scattering. In the case of hydrogen, the calculated intensity of the 0→2 rotational line, the first of the above series, comes out as $3{\cdot}5 \times 10^{-3}$, the observed value being 2×10^{-3}.

Manneback's expressions further show that while the Rayleigh scattering depends on the optical polarisability and anisotropy of the molecules, the vibrational Raman lines are connected with the variation of these quantities with varying nuclear distance. We have at present no experimental knowledge of the latter quantities, but following a method due to Ramanathan[2] it is possible to estimate them theoretically and thus evaluate Manneback's formulæ numerically. In this way it is found that the intensity of the strongest line in the Q branch of H_2 (0→1 vib. 1→1 rot.) when expressed as a fraction of the Rayleigh line should be $1{\cdot}63 \times 10^{-3}$, while the observed value is $1{\cdot}5 \times 10^{-3}$. A qualitative agreement is also found with oxygen (O_2) and nitrogen (N_2). It may be noted that the existence of nearly unpolarised rotational Raman scattering with appreciable intensity necessitates a revision of the hitherto accepted values of the depolarisation of Rayleigh scattering, and this has been taken into account in the above computations.

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[1] *Zeit. für Phys.*, vol. 62, p. 224; 1930.
[2] *Proc. Roy. Soc.*, vol. 107, p. 684; 1925.

Anomalous X-ray Diffraction Intensities.

THE general explanation of the observations previously described under the above heading[1] probably follows, as stated there, from the well-known Laue equations connecting line-breadth with the size of a crystallite measured in a direction a_1. I have recently become aware of a paper by R. Brill,[2] in which this aspect of Laue's work first appears to have been demonstrated quantitatively, and I would like to add this to my former note in order to direct attention to that paper.

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July 17.

[1] NATURE, of May 9.
[2] *Zeit. für Krist.*, **75**, 217.

Research Items.

Hippopotamus Figures from Ancient Egypt.—Mr. W. M. Crompton describes two hitherto unpublished hippopotamus glazed figures in *Ancient Egypt*, 1931, pt. 1. The first was found by the expedition of the School of Archæology in Egypt to the Fayum in 1913–14, in a shaft-grave of the twelfth dynasty near Haregeh. The figure lies with the head turned to the right in a natural pose. It was originally covered with blue glaze, and decorated with designs in black outline, representing the fauna and flora of the marshes frequented by the animal, which was seldom seen except in glimpses through such a foreground. Recently Dr. L. Keimer has published a study of thirty-six decorated hippopotami. On twenty-six examples, including that from Haregeh, decorative motives appear as follows : the flowers of *Nymphaea sp.* appear in all but one, which is entirely decorated with pondweed. The leaves and buds almost invariably appear. Shining pondweed (*Potamogeton lucens* Linn.) appears on five. The papyrus is shown three times only. Rosettes are usual, but not invariable. Birds appear six times ; butterflies three, or possibly four times ; and a bee once. In one instance there is a frog half emerging from a lotus flower. Decorative bands are found four times and a network once. The representation on an animal figure of objects with which it was supposed to be surrounded was not, until recently, known to occur before the Middle Kingdom. It has now been carried back to the Middle Predynastic period ; for Mr. Brunton has found at Badari a fragment of a pottery hippopotamus on which is the design of a ship and men with harpoons, evidently meant as surrounding the animal with intent to destroy it.

Evolution in the Chelonia.—P. E. P. Deraniyagala, in the *Proceedings of the Zoological Society*, Part 4, 1930, gives a reasoned account of his views on testudinate evolution and upholds the thesis that the Athecæ, the leathery turtles, are the more primitive type in the structure of the carapace, as well as in many other features. He points out that the current view that the Athecæ have lost the endoskeletal expansion of the ribs, and consequently the carapace plates, is not necessarily correct, being due to a wrong bias from palæontology. The rarity of Athecæ in any except recent deposits is not due to their recent evolution, but can be explained by the fact that on death their skeletons fall apart and are not preserved as are the well-knit bodies of the Thecophora. As a matter of fact, the earliest known of Chelonian remains, *Psephoderma alpina*, from the Triassic, is claimed as Athecan. The author considers that the original Chelonia were marsh dwellers and at first had a dermal covering with an external layer of ossified scales and a non-retractile neck. It was at this stage that the Athecæ took permanently to marine life, retained the primitive scaling, and never acquired the retractile neck.

Sex-change in the Oyster.—Prof. J. H. Orton and C. Amirthalingam (*Jour. Mar. Biol. Assoc.*, **17**, No. 2, 1931) record observations on sex-change in the European oyster (*Ostrea edulis*). Oysters in which a batch of eggs has been passed into the mantle cavity normally immediately begin to develop spermatozoa, and this process is so rapid that in a few hours after extrusion of the eggs small clumps of spermatocytes can be recognised in the gonad. Within about fourteen hours from the extrusion of ova, relatively large clumps of spermatocytes are recognisable in the gonad, and within about forty-five hours the gonadial tubes become filled with maturing sperm. About eight and a half days after the extrusion of ova, when the larvæ which the oyster is carrying have become fully developed veligers ready to be liberated, sperm development may have proceeded so far that the gonadial ducts become filled with ripe sperm-morulæ. After the larvæ have been liberated, sperm production continues, but about a month after extrusion of the ova begins to wane and in another month has usually ceased if the egg-spawning has occurred in early or mid-summer. The gonad passes into a quiescent condition, and a period of fattening, that is, the accumulation of reserves, usually follows. If egg-spawning occurs in late summer, the sperm afterwards developed may be retained over the winter period. Instructions are given for making the microscopic preparations of the gonad, and illustrations are added to represent the condition as seen in fresh preparations and in sections.

Anterior Abdominal Vein in the Toad.—We have received a communication from Prof. Ekendranath Ghosh and Birendrakumar Mitra, of the Medical College, Calcutta, stating that, while examining about fifty dissected toads (*Bufo melanostictus* Schneider) in a medical examination conducted by Prof. Ghosh, they found a normal-sized anterior abdominal vein, arising in the usual way and ending in the left subclavian vein. The vein had no connexion whatever with the liver or hepatic portal vein. The animal was an adult male. This is the second abnormality of its kind to be recorded for this species. The previous example, where the anterior abdominal vein opened on the right anteriorly, was reported by Bhaduri (*Jour. Dep. Sci.* Calcutta, p. 1, 1929).

A Hypothesis of 'Sub-genes'.—Numerous papers have been published on the inheritance of bristles in *Drosophila*. A group of gene mutations which reduce the bristles in different parts of the body has been studied. These genes are shown by their linkage relations to lie at the scute locus of the *X*-chromosome. To account for these phenomena, Serebrovsky and others have elaborated a hypothesis of 'sub-genes' arranged in linear order, each concerned with the development of one or a few bristles on the fly. The various mutations which scute undergoes are then each supposed to represent a change in a different block of sub-genes. Sturtevant and Schultz (*Proc. Nat. Acad. Sci.*, vol. 17, No. 5) have constructed a similar series of bristle-effects from their experiments, but they interpret it in a different way. Hairless is another gene (in chromosome III.) which removes the bristles in a different pattern from that of the scute series, and achete also inhibits bristle development. By experiments involving these series of forms, it is shown that scute 1 and achete act on bristles throughout the length of the series and not on particular bristles alone. Thus since each 'sub-gene' is affecting many or all the bristles of the fly, though in different degrees in different parts of the body, the basis of the sub-gene hypothesis is undermined and the usual conception of the interaction of genes in controlling development is adhered to instead. The pattern of bristle-effects is explained rather as due to the paths and rates of diffusion of certain substances during development.

Pivots and Jewels.—H.M. Stationery Office has issued at the price of 4*s*. a well illustrated 4to pamphlet of 55 pages describing the work done at the National Physical Laboratory, by Mr. V. Stott, on the conditions favouring smooth running and long life of the pivots and jewels which play so important a part in watches and scientific instruments of all kinds. Mr. Stott has investigated the most suitable shape and hardness of a pivot to carry a given load, and has measured the friction between the pivot and jewel and the torque due to it. He finds that during the rotation of the pivot rust is formed, and that this rust is the main cause of the increase of friction during wear. Lubrication does not diminish the friction between the pivot and jewel, but its presence considerably increases the life of the bearing. The relation between the direction of the hole in the sapphire or diamond and its crystalline axis has an influence on the wear of the bearing.

Flame Propagation in an Electric Field.—Prof. W. A. Bone, R. P. Frazer, and W. H. Wheeler have contributed a paper to the July number of the *Proceedings of the Royal Society* on the effects of an electric field upon the propagation of flame through a dry mixture of carbonic oxide and oxygen. The gas was dried by prolonged contact with phosphoric anhydride, the combustion started by a spark, and the progress of the flame recorded photographically. An electric field was applied between electrodes in the gas, and control experiments made in the absence of a field in otherwise similar apparatus. Their results show a definite effect of the sign of the pole on the flame; near the negative pole conditions are much more favourable to the continuance and propagation of the flame, and near the positive pole rather less favourable than in the field-free control experiments. There appear to be two distinct conditions in which the field has an effect: first, when the flame is being propagated through a dry medium in which the field is maintained, and secondly, when the flame fronts have nearly reached the poles and the field breaks down. In the first instance, there is a general drift of the medium towards the negative pole and also a sort of initial wave of positive ions in the same direction; and in the second, combustion is accelerated by the highly ionised condition of the medium. The paper is illustrated by some beautiful photographs of the moving flames.

Structure of XO_3 Groups in Crystals.—A paper by W. H. Zachariasen in the June number of the *Journal of the American Chemical Society* gives the general results concerning the structure of groups XO_3 in crystals, as determined by X-ray analysis. The groups are found to be of two kinds: (1) co-planar groups; BO_3''', CO_3'', and NO_3'; (2) pyramidal groups; SO_3'', ClO_3', AsO_3''', BrO_3', SbO_3'''. In the following table *a* denotes the oxygen to oxygen distance, *r* the cation to oxygen distance, and *h* the displacement of the cation from the plane of the oxygens, all in angstroms.

	BO_3	CO_3	NO_3	SO_3	ClO_3	AsO_3	BrO_3	SbO_3
a	2·35	2·13	2·14	2·24	2·38	3·28	2·76	3·62
r	1·35	1·23	1·23	1·39	1·48	2·01	1·68	2·22
h	..	..	..	0·51	0·49	0·67	0·56	0·75

The groups XO_3 are co-planar if the number of valency electrons in the group is 3×8, whilst a pyramidal arrangement seems to be connected with $3 \times 8 + 2$ valency electrons. An explanation of the formation of the asymmetrical groups in terms of ions and their polarisibility is given in the paper, and the values of *a* and *h* are shown to be related by the expression $12h = a\sqrt{6}$, which suggests a simple picture of the pyramidal groups as tetrahedral groups with three corners occupied by oxygen ions, the centre by the cation core, and the fourth corner by two displaced electrons or an equivalent concentration of electron density.

Astronomical Topics.

Nagata's Comet.—*Science News Letter*, dated Aug. 1 (Science Service, Washington, D.C.), gives information about the discovery of this comet: Mr. Masani Nagata is a native of Japan engaged on fruit-growing near Brawley, California; he possesses a 3-inch telescope, and in the course of observing Neptune on the evening of July 15 (July 16·2 U.T.) he swept up a nebulous object near it; the next night it had moved a degree to the north-east; he sent the news to Mt. Wilson, where Mr. Moore confirmed the discovery. There was a tail 4° long on July 18; the magnitude of the comet was given as 7 on July 23 and 9 on July 25, but it was probably really brighter, as twilight and atmospheric absorption would weaken its light more than that of the stars.

The following positions (for 1931·0) are from Harvard Cards 161–164:

Date.	R.A.	N. Decl.	Place.
July 18, 1792 U.T.	$10^h\ 40^m\ 44{\cdot}7^s$	9° 50′ 57″	Mt. Wilson
19, 1861	10 45 6·0	9 54 46	,,
20, 1795	10 49 22·3	9 58 12	,,
22, 2004	10 57 56·3	10 4 27	,,
23, 1157	11 1 46·1	10 6 50	Yerkes
25, 1933	11 10 20·8	10 11 22	Lick

The following ephemeris for 0^h U.T. is from *U.A.I. Circ.* 329:

	R.A.	N. Decl.
Aug. 19	$12^h\ 42{\cdot}5^m$	9° 52′
23	12 55·5	9 39
27	13 8·1	9 25
31	13 20·4	9 10
Sept. 4	13 32·4	8 54
8	13 44·1	8 37

The comet is receding from both sun and earth, so the brightness diminishes rapidly. The elements of the orbit show some resemblance to those of the comet of 1804; but this is probably not close enough to make identity possible; the inclination of Nagata's comet is about 14° smaller than that of the other.

Accuracy of the Heliometer.—Prof. de Sitter's George Darwin Lecture is printed in the May number of *Mon. Not. Roy. Ast. Soc.* In the course of it, he discusses the relative accuracy of heliometer measures and of those made on photographic plates. His decision is definitely in favour of the heliometer: he says, "the weight derived from an equal time of observing is for the heliometer more than four times that from one plate". One of the advantages of the heliometer is that the images of the two bodies are brought so close together that the eye can be concentrated on both of them at once. Prof. Schlesinger has shown that oscillations due to our atmosphere are alike for a region of considerable size, so that they do not affect the relative positions of the two bodies. He thinks that a heliometer of focal length 5–7 metres, with a power of 750, showing the satellites of Jupiter as discs, would help to settle a few questions, relating to their motions, that still remain uncertain. Most observers appear to consider the heliometer as obsolete; the Cape is the only observatory where it is extensively used: possibly Prof. de Sitter's words may encourage its reinstatement. It will be remembered that the first reliable star parallax was obtained by Bessel with a heliometer.

Royal Society of Canada.

ANNUAL MEETING IN TORONTO.

On May 20–22 the Royal Society of Canada met at the University of Toronto. During the evening of May 20 Dr. Charles Camsell, Deputy Minister of Mines, gave his presidential address, entitled "Canada's Position in the Mineral Situation of the British Empire". Dr. Camsell, while emphasising the fact that no nation is independent of others in the matter of mineral supply, pointed out that, mainly owing to the diversity and amount of Canada's mineral production, the British Empire approaches much more nearly to a self-supporting basis than any other political unit. At the same meeting, the Flavelle medal was awarded to Dr. F. G. Banting, for his pioneer research on insulin; the Lorne Pierce medal to Adjutor Rivard, for outstanding contributions to literature, and the Tyrrel medal to Dr. Lawrence J. Burpee, for valuable historical work. The customary popular lecture was this year given by Dr. J. S. Plaskett, Director of the Victoria Observatory, on the "Structure and Motions of the Galaxy". A novel feature of the meeting was a series of radio talks by the presidents of the various sections, which were broadcast over the Dominion.

Section III. (chemical, mathematical, and physical sciences) divided into sub-sections to hear its 117 papers. The sectional presidential address was delivered by Prof. F. B. Allan on the position of organic chemistry to-day. A large number of papers were presented on spectroscopy by Prof. J. C. McLennan and his colleagues, Dr. J. S. Foster and his co-workers, Dr. W. H. Martin, and others. Among these papers, mention may be made of a paper by Prof. McLennan and R. Turnbull on "The Absorption Band of Xenon at λ 1469". The results indicate that by the absorption of ultra-violet light of very short wave-length, xenon atoms become enabled to enter a short-lived state of excitation during which they can and may combine with other xenon atoms. They have been able to separate the widening of the absorption band due to the number of molecules from the widening due to the pure pressure effect, for which a theory has been developed and extended by Franck in his lecture at Bristol last summer.

Other papers by Prof. McLennan and Messrs. E. J. Allin, A. B. McLay, M. F. Crawford, L. B. Leppard, A. M. Crookes, and K. E. Hall gave interesting accounts of research work on the properties of atomic nuclei—more particularly the nuclear spins. Further results on the height of the polar auroræ in northern Ontario were presented in a paper by Prof. McLennan, H. Wynne-Edwards, and H. J. Ireton.

Of the papers presented on the Stark effect, the most interesting was on "The Stark Effect in Hα", by D. R. McCrea. Asymmetry in the relative intensities of the components was found in pure hydrogen, which could not be accounted for by the known theoretical probabilities of the transitions. The addition of a small amount of the rare gases causes the intensities to become symmetrical.

In a series of experimental papers on low-temperature work at the cryogenic laboratories of Prof. McLennan, a number of interesting results were reported by Messrs. Wilhelm, Allen, and H. D. Smith. Among these, mention may be made of "The Electrical Conductivity of Ruthenium, Ruthenium Carbide, and Tungsten Carbide", in which the presence of a small amount of W_2C accounted for superconductivity results. Theoretical papers on the superconducting state were given by C. D. Niven, G. C. Laurence, and Prof. L. V. King. Dr. King's paper was perhaps the most outstanding paper of Section III. By assuming that the ion at the space-lattice be polarisable, so that the internal field acting on the free electrons is appreciably different from the measured applied field, he showed that the Wiedemann-Franz ratio depends on the specific inductive capacity of the space-lattice, the variation with temperature of which is given by Debye's formula. A satisfactory explanation is thus afforded of the variation of resistance with temperature. In particular, when the ions have permanent electric moments, the space-lattice may become permanently polarised when the temperature falls below a certain critical value, and superconductivity results. The agreement between theory and the experimental results of Lees and others was satisfactory.

Prof. A. N. Shaw gave new experimental data correlating thermo-electric force with temperature gradients, and Prof. J. Satterly spoke on the surface tension and viscosity effects on a draining plate. Dr. R. W. Boyle presented several papers by his colleagues of the National Physical Laboratory on ultra-sonics and allied subjects. Prof. J. A. Gray gave the results of further experiments on the scattering of X-rays at small angles and on the scattering of β-rays. He also read a short paper on the absorption of γ-rays.

Several papers on geophysics were presented. Prof. A. S. Eve gave the theory of a new method of finding the vertical depth of a buried magnetic dike, which was followed by an experimental paper on the same subject by Prof. D. A. Keys. Prof. L. Gilchrist presented the results of field work, comparing the single and his multiple electrode variation of the single-probe method of geophysical prospecting, and indicating the desirability of the latter arrangement over the region investigated. The results of a torsion balance survey in eastern Canada over pyrite and chromite deposits were read in a paper by A. H. Miller.

In the sub-section of mathematics and astronomy, which met jointly with the members of the Royal Astronomical Society of Canada, papers on astrophysics were read by Dr. J. S. Plaskett, Prof. C. A. Chant, Meldrum Stewart, W. E. Harper, Miss A. V. Douglas, and others. An interesting feature of the joint meeting was an account of the new David Dunlap Memorial Observatory and telescope which have been given to the University of Toronto. The new telescope, which is of the reflecting type, will be the largest in Canada, and the observatory will be under the direction of the Department of Astrophysics of the University.

Papers in pure mathematics were presented by Prof. S. Beatty, Prof. J. L. Synge, Prof. L. L. Dines, Prof. N. R. Wilson, Prof. DeLury, and their colleagues. Among these may be mentioned "The Derivatives of an Algebraic Function", by Dr. Beatty; "Constructing Basis for an Algebraic Number Field", by Dr. Wilson; "On Sets of Functions Orthogonal to a Positive Function", by Dr. Dines.

A large number of papers were presented in the chemistry sub-section by Profs. Lash Miller, O. Maass, H. Hibbert, and R. H. Clarke, and their associates. Prof. M. C. Boswell and W. H. Hutcheon spoke on an apparatus for studying the conditions influencing the yield of methyl chloride in the action of chlorine on methane, and Prof. J. B. Ferguson presented a paper on the co-existent vapour and liquid phases in the system, normal hexane-methyl alcohol at 45° C.

A demonstration of the new optical meteorograph was given by Mr. J. Patterson, secretary of Section III., by which the temperatures and pressures may be indicated in the upper atmosphere at night by means of electric light flashes. Prof. A. Norman Shaw was elected president of the Section for the coming year.

In Section IV. (geological and mineralogical sciences) thirty-one papers were presented. The meetings of the Section opened with the address of the president, Dr. E. M. Kindle, on "A New Viewpoint on Palæontology", in which he explained the preparation of a printed card index illustrating and describing type fossils. The attention of the Section was mainly occupied with a symposium on batholiths, H. C. Horwood, J. S. DeLury, T. T. Quirke, E. L. Bruce, J. A. Dresser, S. J. Schofield, W. T. Wright, and D. R. Derry contributing.

Papers on the late glacial history of the Great Plains were read by W. A. Johnston and D. A. Nichols, and E. S. Moore described an old glacial valley on Michipicoten River, northern Ontario. Papers also dealt with the following subjects: "The Devonian and Siberian Rocks of Gaspe and Northern New Brunswick, and Topographic Deflections in the Gaspe Peninsula" (F. J. Alcock); "A New Lower Jurassic Fauna in the Rocky Mountains" (P. S. Warren); and "The Re-crystallisation of Gypsum, illustrated by Microphotos on Cinema Films" (G. M. Thomson). Other papers were read by titles and will appear in the transactions. Mr. W. A. Johnston was elected president of the Section for the coming year.

In Section V. (biological sciences) sixty-six papers were presented. The presidential address by Dr. Jas. Miller was on the subject of "The Glomerulus of the Kidney: An Anatomical and Pathological Study". As an historical review and a summary of recent work, the address, printed in the proceedings, will be useful. Botanical papers came first. Frère Marie-Victorin presented a series of papers by himself and co-workers, extending their important phytogeographical and taxonomic studies of the flora of the north-eastern part of Canada. Various new relic species were described.

F. E. Lloyd classified *Utricularia* species according to their trap mechanism. G. W. Scarth presented a paper by himself and A. B. Brown on the "Effects of Temperature on Stomata"; A. H. R. Buller showed that a yeast *Sporobolomyces* discharges aerial spores in the same manner as *Basidiomycetes*, and should probably be classed among the latter. He also described the phenomenon of puffing in the *Discomycetes*. Papers presented by W. P. Thompson were taken as read in his absence.

Anatomical, biochemical, pathological, and physiological topics were dealt with by the majority of the papers in this Section. Mention may be made of the following: Pierre Masson, "Sur les propriétés organogéniques des cellules de Schwann". J. G. Fitzgerald and co-workers were responsible for some seventeen papers on toxins, sera, etc. Among the more notable were: the account by N. E. McKinnon and Wm. Knowles of "A Concentrated Anti-Vaccinal Serum" which may prove to be of value; that by C. H. Best, H. C. Foster, and L. Irving on "The Fate of the Sugar which disappears under the Action of Insulin" (confirming and extending the work of Best, Hoet, Marks, and Dale); and that by A. F. Charles and D. A. Scott on "Acetylation of Crystalline Insulin". Hardolph Wasteneys presented, among others, an interesting paper by H. D. Jenner and H. D. Kay on "The Place of Mg in the Phosphatase System", also one by A. A. Fletcher and Florence Hargreaves on "The Colon Condition in Rats with Vitamin B Deficiency", and one with B. F. Crocker, entitled "A Note on the Equilibrium of Peptic Synthesis".

Several papers were presented by V. J. Harding, of which one by T. F. Nicholson on "The Effect of Large Amounts of Urea on the Acid-Base Equilibrium of the Dog" raised the unanswered question of whether urea can function as a base; and another by Harding and D. E. Selby described how yeast (which ordinarily will not hydrolyse galactose) can be trained to do so in three generations, and can be used accordingly in urine analyses.

Among the more significant of the papers presented by Dr. J. B. Collip was one by J. W. Allardyce and L. I. Pugsley on "A Comparison of the Effect of Vitamin D and the Parathyroid Hormone on the Calcium and Phosphorus of Serum and Urine". Dr. Collip summarised in another contribution the physiological and chemical properties of the placental hormones. B. P. Babkin, in a paper on "The Innervation of the Salivary Glands", described the different effect of parosympathetic and sympathetic nerves on these glands. Jas. Miller, F. R. Miller, and V. E. Henderson also presented papers.

On zoological topics only a few papers were presented, namely, one by C. McLean Fraser on the ecology of the cockle; two by E. Home Craigie (presented by B. A. Bensley) on the cerebral anatomy of the humming bird and of the wild Norway rat v. albino, respectively; and one by A. Willey, entitled "*Glossobalanus Berkleii*, a New Enteropneust from the West Coast". Dr. J. B. Collip was elected president of the Section.

The president of the Society for the ensuing year is Sir Robert Falconer, Principal of Toronto University, and the vice-president, Prof. F. E. Lloyd of McGill. It is hoped that the 1932 meeting will take place in Vancouver, but no definite arrangement has yet been made.

Conference of Empire Survey Officers, 1931.

THE second conference of Empire Survey Officers, convened by the Secretary of State for the Colonies, was held on July 8–28, and, as a result of a decision taken at the first Conference in 1928, was devoted mainly to the subject of cadastral and property surveys and land registration. At the same time, opportunities were taken for giving attention to other branches of survey.

The meetings were held generally at the Science Museum, placed at the disposal of the Conference by Sir Henry Lyons, representing the Board of Education; but meetings were held also at the War Office, Surveyors' Institution, University of Cambridge, Admiralty, the Thames (Port of London Authority), Nautical Almanac Office, Royal Observatory, Southampton (Ordnance Survey), Liverpool Observatory and Docks, York, and Hull. At the last port delegates were permitted by the Admiralty to observe hydrographical methods on two of H.M. surveying ships operating in the North Sea.

Of the Dominions, Canada, New Zealand, and Newfoundland were unfortunately unable to send delegates, and of the Colonies only fourteen were represented, the world-wide depression being mainly responsible. In practically all cases, delegates were either survey officers at home on periodic leave or for other reasons.

The pressing need for extensive revision of the

Ordnance large-scale maps of Great Britain was brought to notice by Sir Charles Close, sheets in some cases being forty years out of date. Methods of map reproduction at home and in the tropics were discussed at the Ordnance Survey, Southampton, where Brigadier H. St. J. L. Winterbotham, the initiator and president of the Conference, and Major Clough, gave a description of the latest methods and processes of map-making. Triangulation was discussed by Dr. de Graaff Hunter and Capt. Calder Wood; traverses by Mr. J. Clendinning; gravimetry and the training of European surveyors were treated at Cambridge by Sir G. P. Lenox-Conyngham, Col. Craster, Prof. F. Debenham, and others; while Sir John Flett gave a remarkably lucid lecture on geophysical surveying, and Drs. Jeffreys and Hunter dealt with the relations between geophysics and geodesy. Air survey was brought forward by Capt. M. Hotine, air photography by Flight-Lieut. J. Bussey, aeronautical maps by Squadron Leader P. H. Mackworth, and air survey as applied to cadastral mapping in India by Col. R. H. Phillimore; a paper on the airman-surveyor by Mr. P. E. L. Gethin provoked a lively discussion. Admiral H. P. Douglas, to whom the success of the Conference was due in no small measure, described hydrographical methods. A summary presentation of the present knowledge of tides in British waters was given by Prof. J. Proudman, following an admirable description of tidal instruments by Prof. A. T. Doodson; Comdr. E. C. Shankland lectured on the hydrology of the Thames estuary. Optical distance measurement was dealt with by Major R. L. Brown, and the possible improvement of the barometer was not ignored. Sir Henry Lyons described early methods of survey in Egypt and the Roman Empire. The Astronomer-Royal gave the results of the most recent experience on the reception of *W/T* signals, and Dr. L. J. Comrie gave a lecture on the *Nautical Almanac* and mechanical computation.

It will be seen that much ground was covered outside the main work of the Conference. Within this sphere there was an eloquent address from Sir John Stewart-Wallace on land registration in Britain. Papers on land survey were sent by Mr. F. H. Peters, Surveyor-General of Dominion Lands, Canada, by Mr. A. H. G. Dawson, Surveyor-General of Ceylon, and by Mr. W. F. N. Bridges for the Surveyor-General of Malaya, the latter being a complete account of the survey and registration in that Colony. Mr. Maxwell Edwards, Surveyor-General of the Transvaal, and Mr. W. G. Fairweather of Northern Rhodesia read papers on property surveys and registration in their respective spheres. Lieut.-Col. C. H. Ley sent a paper describing the somewhat difficult cadastral structure of Palestine; another came from Mr. C. O. Gilbert, the Director of Surveys in Kenya. Col. M. O'C. Tandy annotated a paper by Cols. Campbell and Gwynn on rectangulation surveys in India, which bear some relation to the system in the Prairie Provinces of Canada; the discussion was continued by Colonel MacLeod, Chief of the Geographical Section of the General Staff, whose organising ability contributed greatly to the success of the meetings, at which he often took the chair in the absence of the president. It is not possible to summarise all the work done by willing hands in the field of land survey, but it may be said that there were few of the difficulties in the Empire which were not ventilated. A most instructive exhibit of cadastral maps was arranged at the Science Museum by the spontaneous labours of Sir E. M. Dowson; this was by no means limited to the Empire, since France, Italy, Switzerland, and Egypt made generous contributions, often involving a considerable amount of work.

Other subjects discussed were topography, the training of native surveyors, the *Empire Survey Review*, the Field Survey Association, and the position of the licensed surveyor in Canada, Kenya, Trinidad, etc.

These first two conferences have owed their success largely to the efforts of Sir Cecil Bottomley and to Mr. E. B. Bowyer, chairman and joint secretary of the Colonial Survey Committee. The proceedings will be published by H.M. Stationery Office early next year. It was decided to recommend the convening of a third Conference in 1934.

Coloured Glass as a Deterrent to House Flies.

An interesting series of tests with the object of finding whether rooms glazed with 'Calorex' are likely, by virtue of the special properties of the glass, to be freer from insects than rooms glazed with ordinary glass has recently been carried out at the Imperial College of Science and Technology under the supervision of Prof. J. W. Munro, on behalf of Messrs. Chance Brothers and Co., Ltd.

Calorex glass is of a pale greenish-blue tint, and is designed to afford protection from excessive solar radiation by strongly absorbing infra-red radiation whilst transmitting in a useful degree the radiation within the visible spectrum. The present experiments, which have been conducted with several types of insect, but mainly with flies, bees, and wasps, confirm and amplify observations made at the Building Research Station at Garston, Herts, and described by Mr. H. E. Beckett in Nature.[1]

House flies (*Musca domestica*) exposed to sunlight in a box, one half of which was glazed with Calorex and the other with ordinary glass, showed a marked preference for the ordinary glass, the ratio of the numbers of insects in the two halves, averaged over several experiments, being about 9 : 4. These results were verified by other tests in which the insects were not enclosed within the box but were attracted to it by a suitable bait. Wasps and bees were found to behave in the same way as flies.

Much of the preference shown is ascribed to the inequality of temperatures beneath the two kinds of glass, the disparity in insect population being greatest when the maximum temperature differences were observed. Confirmatory evidence of a positive effect with temperature differences maintained by agencies other than radiation is not, however, chronicled.

That an effect can definitely be ascribed to the colour of the light which has passed through Calorex was demonstrated by an experiment in which bees were enclosed in a glass cylinder, one end of which was closed with Calorex and the other with ordinary glass. By interchanging the glasses an immediate reaction was obtained, the bees moving to the end covered with ordinary glass.

The effect of coloured light does not seem to be peculiar to blue light. Messrs. Pilkington Brothers, Ltd., from experiments conducted last year, have stated [2] that the house fly prefers white light to coloured light, and that red and yellow are the best deterrents, being considerably more effective than blue and green. On the other hand, it has been stated [3] that blue glass is completely effective.

The most extensive use of coloured glass for this purpose at present seems to be in meat stores. In such buildings yellow glass is unpopular on account of the sickly appearance which it imparts to the meat, and blue glass has been used with some success. In

Holland the use of blue glass has, moreover, been extended to cow-houses with beneficial results. The glass, although of a distinctly different tint from Calorex, appears to share with the latter to some extent its power of absorbing the infra-red radiation of the sun, so that temperature effects may be partly responsible for the positive results obtained. The value of yellow glass cannot, however, be ascribed to such an effect. More information is obviously required on this most practical problem.

[1] NATURE, 125, 780, May 24, 1930.
[2] NATURE, 125, 529, April 5, 1930.
[3] NATURE, 125, 780, May 24, 1930.

University and Educational Intelligence.

BIRMINGHAM.—The vacancy caused by the retirement of Prof. F. W. Burstall from the chair of mechanical engineering has been filled by the appointment of Mr. Samuel Lees. Mr. Lees studied at Manchester College of Technology and St. John's College, Cambridge. He took the Mathematical Tripos and afterwards did research under the late Prof. B. Hopkinson, being elected to a fellowship of St. John's College in 1912. He was Hopkinson lecturer in thermodynamics at Cambridge (1919–29) and director of engineering studies at St. John's College (1924–29). Since 1929 Mr. Lees has been consulting engineer to Messrs. Silica Gel, Ltd.

LEEDS.—The University has instituted a diploma in public administration, the course of study for which will commence in October 1931. The course will extend over two winter sessions.

SHEFFIELD.—The Council of the University has decided to appoint a professor of electrical engineering. It is hoped to make the appointment in time for him to take over his duties in the early part of 1932.

MR. SIDNEY WEINTROUB, of St. John's College, Oxford, has been appointed an assistant lecturer in physics at University College, Southampton.

THE Wilbur Wright memorial lecture of the Royal Aeronautical Society will be delivered on Wednesday, Sept. 16, at 9.15, in the Science Museum, South Kensington, by Mr. Glenn Martin, who will take as his subject "The Development of Aircraft Manufacturing".

THE following scholarships for 1931 have been awarded by the Institution of Electrical Engineers: Duddell Scholarship (annual value £150; tenable for 3 years): C. H. W. Clark (Sevenoaks Grammar School); Silvanus Thompson Scholarship (annual value £100, plus tuition fees; tenable for two years): C. H. Lackey (Messrs. A. Reyrolle and Co., Ltd.); David Hughes Scholarship (value £100; tenable for 1 year): G. L. d'Ombrain (City and Guilds (Engineering) College); Salomons Scholarship (value £100; tenable for 1 year): S. H. Padel (Manchester College of Technology); War Thanksgiving Education and Research Fund (No. 1): grants of £50 each to F. J. Clark (East London College) and J. H. Wagstaff (University College, London); Thorrowgood Scholarship (annual value £25; tenable for 2 years): P. W. Ottley (Underground Electric Railway Company of London, Ltd.); Paul Scholarship (annual value £50; tenable for 2 years): W. T. Darwin (L.C.C. School of Engineering and Navigation).

Birthdays and Research Centres.

Aug. 16, 1863.—Prof. F. S. KIPPING, F.R.S., professor of chemistry in University College, Nottingham.

Nearly thirty years ago the study of some organic derivatives of silicon was commenced, with the primary object of proving that compounds of the type $SiR_1R_2R_3R_4$ existed in enantiomorphously related, optically active forms. During the progress of this work, various interesting by-paths were encountered and, with the help of many students, some of these have been partly explored. The results have indicated that silicon analogues of many of the more important types of carbon compounds cannot be obtained, and that silicon is incapable of uniting with itself, with carbon, or with oxygen, by a 'double bond'. On the other hand, the formation of chains of silicon atoms, linked together directly or by an atom of oxygen, often takes place with unexpected facility, giving highly complex products, many of which cannot be isolated and identified.

Aug. 19, 1868.—Prof. W. BULLOCH, F.R.S., Goldsmiths' professor of bacteriology in the University of London.

Ever since Lister (1869) introduced into surgery the principle of the antiseptic absorbable ligature in the form of catgut, this has always been a problem. Some years ago I was requested by the London Hospital authorities to investigate complaints regarding the sterility of samples of catgut sold in commerce. Much of the 'sterile' catgut was found not to be so, and the catgut sold by several manufacturers was found indeed to be uniformly (100 per cent) infected and presumably harmful. To remedy this so far as my own hospital was concerned, I carried out a systematic investigation of the methods of sterilising catgut, and this involved testing more than 30,000 ligatures. Two methods were found to be effective in producing sterile catgut. In conjunction with Messrs. Lampitt and Bushill, of the laboratories of J. Lyons and Co., a report was issued by the Medical Research Council, and the result was that surgical catgut was brought under the Therapeutic Substances Act, and the tests we had laid down were enforced. Two years' experience of the new conditions relative to the manufacture of surgical catgut in England and abroad has shown that at the present time the catgut is much better than was previously the case, and the risk of ligature infection in surgical operations has been greatly diminished.

In my leisure I devote my time to the study of the history of the sciences associated with medicine.

Aug. 19, 1874.—Prof. A. H. REGINALD BULLER, F.R.S., professor of botany in the University of Manitoba.

I am interested in the relations of fungi with various animals; and two species of Fungi Imperfecti, which attack and kill large numbers of larval nematode worms (*Strongylus* species, parasites of the horse) as these wriggle about in horse dung, are being investigated in my laboratory.

My chief occupation just now is the completion of the manuscript and the illustrations for another volume of my "Researches on Fungi". This volume, in part, will treat of *Pilobolus* and the ocellus function of its subsporangial swelling, *Sporobolomyces* regarded as a basidiomycetous yeast, *Tilletia tritici*, which causes the stinking smut disease of wheat, and *Sphærobolus stellatus*, a small gasteromycete allied to the puff-balls, which can shoot its ball of spores a horizontal distance of eighteen feet.

Aug. 19, 1885.—Prof. A. J. CLARK, F.R.S., professor of materia medica in the University of Edinburgh.

We know something of the metabolism of the skeletal muscles, but practically nothing about the metabolism of cardiac and plain muscles. The latter group is, however, more important in certain respects than is the former.

The differences in function shown by the different types of muscles make it probable that their metabolic processes differ widely. Skeletal muscle is a very highly specialised tissue, whereas cardiac and plain muscles are somewhat less specialised. The metabolic processes of the latter group deserve, therefore, far more attention than they have hitherto received.

Societies and Academies.

CRACOW.

Polish Academy of Science and Letters, May 4.—I. Neyman and E. S. Pearson: The problem of k samples.—W. Goslawski and L. Marchlewski: The absorption of ultra-violet radiations by certain organic substances.—K. Dziewonski and St. Pizoń: A new method of synthesis of dinaphthopyrone. Dibenzoxanthone can be obtained directly by the interaction of β-naphthol and carbanilide or thiocarbanilide.—Mlle. Bron. Mlodzianowska: The earliest stages of the development of *Cysticercus fasciolaris* of the larva of *Taenia taeniaeformis*.—S. Skowron and T. Pawlas: Observations on the influence of gonacrine on the organism.

June 12.—St. Mrozowski: The hyperfine structure of the resonance line of mercury (2).—S. Szczeniowski and L. Infeld: The effect produced by a cloud of electrons on the structure of the de Broglie wave.—Mlle. A. Dorabialska: Microcalorimetric measurements of the period of polonium. The period found by this method was 137·6 days.—M. Hlasko: The differences between the conductivity coefficients of strong electrolytes in the same solvents.—M. Hlasko and W. Klimowski: The conductivity of certain mineral acids and the mobility of the hydrogen ion.—K. Dziewoński, W. Kahl, and Z. Olszewski: Study of the compounds derived from naphthalic acid. The synthesis of 3, 4-dihydroxynaphthalic acid.—E. Mnich: The phosphorus compounds of plants (6). The solubility of the phosphorus compounds of bean flour and the faculty of phytine of combining with protein substances which it contains.—Tymrakiewicz: The stratigraphy of the peat bog situated near Dublany, Olesko, and Opaki. Three climatic periods were shown by pollen analysis.—J. Jarocki and A. Demianowicz: The presence of a Ponto-Caspian amphipod, *Chaetogammarus tenellus*, in the waters of the Vistula.—L. Ejsmont: The identity of *Proshystera rossittensis* and of *Tanaisia fedtschenkoi* with some remarks on trematodes with united cæca.—J. Hirschler: Observations concerning the reciprocal influence of insects.—Z. Grodziński: The development of the blood vessels in the pectoral fin of fishes belonging to the genus *Salmo*.—F. Rogoziński: Experimental rickets (3). The influence of ammonium chloride on the mineral metabolism of the rachitic rat.

GENEVA.

Society of Physics and Natural History, May 7.—Albert H. Du Bois: Variations of the blood serum albumins under the influence of reticulo-endothelial blocking. In the rabbit, blocking the reticulo-endothelial system with 2 per cent Chinese ink by endovenous injection (1 c.c. per day) affects the proportion of the blood serum albumins. The serin diminishes, the globulin increases, and the ratio serin to globulin tends to be inverted. Moreover, the colloido-osmotic pressure of the blood serum falls as a result of the loss of serin.—Ch. Eug. Guye: The lower limit of physico-chemical phenomena. A physico-chemical phenomenon is first defined as that of which the complete interpretation reduces in the final analysis to ideas of space, time, and matter, ideas which have been established by experiments on a macroscopic scale. In the field of intra-atomic and quantic phenomena, these ideas appear to lose all exact experimental meaning, and the question arises as to how far they can be rightly applied in a field which is not their field of origin. Planck's constant appears to limit physical chemistry on our scale; beyond this, all is mystery. It is a great temptation to find in this indefiniteness the origin or the causative principle of the organisation of life and thought. M. Guye recalls, moreover, in this connexion, that when a material system contains only a small number of molecules (micelles, filterable virus, etc.) the statistical fluctuations then assume considerable importance and the intimate nature of the individual molecular actions ought to be made clearer.—P. Balavoine: A formula for the determination of the alcoholic strength of brandy. The author gives a simple formula for determining the alcoholic percentage to 0·1 per cent in a liquid containing between 30 and 70 per cent of alcohol, and not containing more than 10 grams of extract (syrup, etc.) per litre.

SYDNEY.

Linnean Society of New South Wales, April 29.—Frank A. Craft: The physiography of the Shoalhaven river valley. (1) Tallong-Bungonia. A topographic survey of the Tallong district reveals three major series of features—a peneplain level at 2200 feet, an incomplete peneplain or series of very flat valleys at 2000 feet, and deep gorges which come within 350 feet of sea-level. From consideration of the land forms it is concluded that the surface of the tableland was elevated to its present altitude by a series of uplifts, of which the most recent has been largely responsible for the formation of the deep gorges.—H. M. R. Rupp: Further notes on the orchids of the South Maitland coalfields, with description of a new *Dendrobium* from Bullahdelah. The occurrence is noted of *Calochilus cupreus* Rogers in New South Wales, and its confusion with *C. campestris* R. Br. is discussed. Several interesting teratological orchid forms are recorded, also a hybrid *Pterostylis ophioglosa* R. Br. × *Pt. concinna* R. Br. The identity of *Pt. Mitchellii* Lindl. is considered, and a striking form at present included under *Pt. pusilla* Rogers is described as a new variety. The new *Dendrobium* from Bullahdelah is closest to *D. speciosum* Sm. and *D. Kingianum* Bidw.—H. L. Jensen: Contributions to our knowledge of the Actinomycetales. (1) A case of hereditary variation in the genus *Actinomyces*. A soil micro-organism (probably identical with *A. polychromogenes* Vallée) normally forms cells resembling corynebacteria or mycobacteria. A variant, appearing as long, branched filaments of an entirely *Actinomyces*-like character, arises spontaneously in cultures of the former type. Besides this, several other variants are produced, partly spontaneously, partly experimentally. The bearing of these and similar phenomena on the taxonomy of the genus *Actinomyces* and related genera is discussed.

May 29.—A. M. Lea: On Baridiinæ (Curculionidæ), mostly from New Guinea. The paper consists of descriptions of sixty-seven new species of weevils from New Guinea (including a new genus), Aru, Fiji, Malay

Peninsula, Java, and Queensland.—G. H. Cunningham: The Gasteromycetes of Australasia (11). The Phallales (pt. 2). Under the Clathraceæ are placed eleven genera. The family is rearranged, and divided into three tribes upon the nature of the receptacle of the fructification. A new family is represented by the solitary genus *Claustula* containing *C. Fischeri*. All genera and species are redescribed, their relationships shown and known collections in existence in herbaria of the world are listed.—Mary E. Fuller: The life-history of *Calliphora ochracea* Schiner (Diptera, Calliphoridæ). This paper describes the morphology of the earlier stages of the blowfly *Calliphora ochracea* Schiner, and includes some observations on the biology of the fly. The natural breeding habits of the species are not known, but in captivity it has been induced to oviposit on fur covering meat. The hitherto unknown larvæ have been obtained in quantity, and numbers of adults bred through, giving the complete life cycle. —H. L. Jensen: A note on the systematic position of *Mycobacterium cœliacum* Gray and Thornton. This organism agrees morphologically with the genera *Mycobacterium* and *Corynebacterium*. The suggested transfer of it to the genus *Flavobacterium* is therefore not justified.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 17, No. 4, April 15).—Harvey Cushing: (1) The reaction to posterior pituitary extract (pituitrin) when introduced into the cerebral ventricles. A patient recovering from an operation for a tumour on the brain offered himself for the investigation. Injection of surgical pituitrin into the lateral ventricle of the brain caused pronounced flushing (vaso-dilatation) and excessive sweating (except of the skin over the bone flap) with drop of body temperature and metabolic rate. The effect is almost the reverse of that produced by intramuscular or intravenous injections, which cause blanching of skin and mucous membranes (vaso-constriction) and prompt evacuation.—(2) The similarity in the response to posterior lobe extract (pituitrin) and to pilocarpine when injected into the cerebral ventricles. These substances have very similar effects, suggesting a central autonomic stimulation chiefly of the parasympathetic division.—(3) The action of atropine in counteracting the effects of pituitrin and of pilocarpine injected into the cerebral ventricles. Whether given subcutaneously or previously injected into the cerebral ventricles, atropine appears completely to counteract the effects of pituitrin and pilocarpine injected into the ventricles.—Wilder D. Bancroft and S. F. Whearty, jr.: (1) Activation by charcoal. Chlorine and benzene in the presence of purified activated charcoal form ring-substitution products. —(2) Aromatic substitution products with fluorine. Gaseous fluorine gives substitution products with hexachlorobenzene.—Wilder D. Bancroft and J. E. Rutzler, jr.: Reversible coagulation in living tissue (2). Following up previous work on the coagulation of nerve protein by drugs and its peptisation by sodium thiocyanate, it is suggested that, in the absence of organic ailments, morphine addicts might be cured by the use of this salt.—R. E. Bowen: Movement of the so-called hairs in the ampullar organs of fish ears. Ecker recorded movements of the hair cells of *Petromyzon* in 1844; similar movements, at very varying rates, occur in the teleost *Ameirus nebulosus*. —Charles W. Metz and Helen Berenice Smith: Further observations on the nature of the *X*-prime (X') chromosome in *Sciara*.—Tracy Yerkes Thomas: On the unified field theory (5).—Jesse Douglas: The least area property of the minimal surface determined by an arbitrary Jordan contour.—A. D. Michal: Function space-time manifolds.—A. A. Bless: The composition of the interior of the earth. It is assumed that the temperature gradient in the crust extends to great depths; this leads to the view that dissociation of molecules takes place at great depths, and that the earth consists of the present crust with permanent gases, while the other elements form a core. It is also assumed that the composition of the earth as a whole is similar to that of the upper layers of the sun. The suggested ionisation of the core elements leads to a liquid core of high density, as required by seismic observations. The theory is put forward tentatively as a means of avoiding the hypothesis of a core of heavy metals, chiefly iron.—W. V. Houston and C. M. Lewis: Rotational Raman spectrum of CO_2. The microphotometer curves show a rotation band of equidistant lines. Even rotational states alone are present, and the moment of inertia is $70 \cdot 2 \times 10^{-40}$ gm. cm.^{2}.

Official Publications Received.

BRITISH.

Journal of the Royal Statistical Society. New Series, Vol. 94, Part 3. Pp. 359-486+xiii. (London.) 7*s.* 6*d.*

Trinidad and Tobago. Minutes and Proceedings of the Sugar Cane Investigation Committee. Part 21. Pp. 269-331. (Trinidad: Government Printing Office.)

Transactions of the Institute of Marine Engineers, Incorporated. Session 1931, Vol. 43, No. 6, July. Pp. 261-304+xlii. (London.)

Experimental Researches and Reports published by the Department of Glass Technology, The University, Sheffield. Vol. 13, 1930. Pp. 288. (Sheffield.) 7*s.* 6*d.*

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4 (New Series), No. 6, June. Abstracts Nos. 960-1140. Pp. 187-222. (London: H.M. Stationery Office.) 9*d.* net.

South Australia: Department of Mines. Mining Review for the Half-year ended December 31st, 1930. (No. 53.) Pp. 147+3 plates. (Adelaide: Harrison Weir.)

Royal Commission on the Civil Service, 1929-31. Report. (Cmd. 3909.) Pp. viii+252. (London: H.M. Stationery Office.) 3*s.* 6*d.* net.

The Annual Report of the Gresham's School Natural History Society. Pp. 39. (Holt.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 14, Part 3, July 28. Pp. 221-250+plates 3-8. (Pretoria.)

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FOREIGN.

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