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Acoustic Research.

THE work of men of science has laid the foundation for a great many improvements in the technique of building, and this is, perhaps, most directly evident in the domain of physics. The utilisation of energy in the forms of heat and electricity form striking examples, but little has been done in this country in connexion with the control of sound. This is somewhat curious since in the late Lord Rayleigh we possessed one of the greatest exponents of acoustics. With the present-day congestion of our towns, which seems to be an inevitable factor in the progress of civilisation, the reduction of noise becomes of constantly increasing importance, and the present financial loss due to this cause must be very great, though probably impossible to estimate. Need also exists for investigation on the most efficient means of propagating sound in order to secure its most effective transmission and reflection.

The production of an acoustically successful auditorium is frequently of paramount importance in connexion with architectural design. Many of our public buildings erected by eminent architects show considerable faults in this direction, and as we may assume that these faults are not due to professional apathy, it would seem that the laws regulating the production of a successful building for hearing and speaking have yet to be worked out.

Unfortunately, the variations in the factors which have to be considered are many, and no two designs are wholly identical. Some opinions on this subject have recently been stated in the public press in connexion with the hall of the London County Council building, and the views expressed suggest that men of science are agreed that there is work to be done, and also need for work already done to be reduced to a form capable of absorption by the designer and constructor. Sir William Pope considers that quite a small expenditure of time and money would suffice to provide knowledge enough to enable an architect to render every hall acoustically perfect, but this view is evidently not shared by Sir Joseph Larmor; and others will be found who regard the subject as less easy of solution than might appear from the consideration of simple cases only.

Nor is the acoustic efficiency of public halls by any means the conclusion of the whole matter. There are more numerous cases in which the direct absorption of sound is of as great importance as is transmission in auditoria. In the hospital ward, the private sick-room, and in the office, where quiet and ventilation are so often incompatible, the best means of destroying unwanted sounds calls for scientific investigation.

That architects are not entirely indifferent to this subject is shown by the fact that on the formation of the Department of Scientific and Industrial Research several years ago, the Royal Institute of British Architects formally directed attention to the need for acoustic experiments, associated with design and construction.

This need is recognised elsewhere, as is evidenced by the work done in America where, at Geneva, Illinois, in the laboratory of acoustics built for the late Prof. Sabine by Col. Fabyan, much valuable research has been carried out. Before his death in 1919 at the age of fifty, Prof. Sabine had collected a great deal of experimental data on sound in relation to materials, and his researches had sufficiently impressed themselves on American architects more than twenty years ago to result in consultations on acoustic design. The laboratory is now under the direction of Prof. Paul E. Sabine, some of whose recent researches are referred to elsewhere in this issue with a brief description of his laboratory. In this building, devoted solely to acoustic problems, the difficulties of adequate sound transmission and suppression are constantly being investigated. Work of this nature must eventually prove a valuable national asset by preventing wasted effort and expenditure, and the example of America is worth serious consideration in this country.

There are a great many problems in which the work of the man of science can materially assist the architect, not only in acoustics but also in the use of materials for construction generally, but if science is to have its due appreciation it must supply information of a practical and simple kind which will appeal to workers in a field already so wide that they have little time for the study of theory, however interesting.

The Body Temperature of Birds.

A Study of the Body Temperature of Birds. By Alexander Wetmore. Smithsonian Miscellaneous Collections, Vol. 72, Number 12. (Washington, D.C., U.S.A.: Smithsonian Institution.)

WITH regard to body temperature, animals are divided into two great groups, namely, warm-blooded and cold-blooded, the former including mammals and birds, the latter reptiles, amphibians, fishes, and all invertebrates. A more accurate distinction than the actual temperature, however, is based on the fact that the so-called warm-blooded animals have a constant temperature (homoiothermal) while the cold-blooded animals have a variable temperature which is practically the same as that of the environment in which they live (poikilothermal).

The essential difference between these two groups is, that homoiothermal animals—mammals and birds—possess a heat-regulating mechanism by means of which the heat production and heat loss are so balanced that the body temperature remains practically constant, while poikilothermal animals—all others, except mammals and birds—possess no such mechanism.

Although much time and research have been devoted by a host of investigators to the study of body temperature and heat production in mammals, comparatively little attention has been given to this field in avian physiology, and all interested in this much-neglected subject will be greatly indebted to the author of the above monograph for his important and valuable contribution.

The investigation covered a period extending from January 1912 to October 1919, and records were obtained from 1558 individuals of 327 species of birds distributed among 50 families. It was carried on within the limits of the United States of America, and all the year round, in temperate regions where the extreme cold of winter is not encountered. In addition to the 327 species examined by the author personally, the previously published records from 89 others are given in the form of a supplementary table, so that definite statements may be found in the work regarding the body temperature of 416 species of birds. A table giving the individual records in detail, not included because of the high cost of printing, is deposited in the files of the Smithsonian Institution of Washington, and may be consulted by those interested.

Specially constructed thermometers of the clinical type but with a wider range—95° F.+ to 115° F.+—were used. When a bird was shot a temperature reading was taken from the large intestine reached through the anus or from the proventriculus through the mouth, only when the specimen could be secured immediately. If there was any delay in retrieving a correct reading could not be made, so that it was only possible to secure records from less than half the birds collected. In the short time that intervened between the shooting and introduction of the thermometer, it is assumed that no appreciable loss of heat from the body took place, and that the figure recorded indicates the temperature immediately before death.

With regard to the diurnal rhythm of body temperature found in all homoiothermal animals, including man, the author was able to corroborate the work of previous observers, and it is particularly interesting to note that in nocturnal birds, such as owls, the normal rhythm is reversed, the temperature being highest during the night (period of activity) and lowest during the day (period of rest).

Hilden and Stenback found that by imposing an

artificial night (period of darkness) and day (period of artificial illumination) on birds confined in a darkened room the temperature rhythm was altered. After the second day the diurnal birds adapted themselves to the changed conditions so that the maximum temperature occurred at night and the minimum during the day. When the experiment was ended and birds again led a normal life in relation to daylight, the diurnal rhythm quickly returned. A similar change of rhythm has been produced artificially in the monkey. This bears on the question as to the cause of the diurnal temperature rhythm in animals. Some believe that there exists in the body a fixed periodicity of which the temperature rhythm is an expression, and that this periodicity persists under all conditions, and is, to a large extent, independent of outside influences. Others are inclined to question the existence of this mysterious periodicity, and look upon the diurnal variation as being due entirely to the action on the body of the various outside influences which affect body temperature, notably, muscular activity and sleep. The fact that the rhythm may be altered by changing the daily routine appears to give support to the latter view.

Although a distinct diurnal body temperature rhythm is found in birds with a wider range in many cases than in mammals, there is little evidence of a seasonal variation. This is all the more interesting, since no class of non-hibernating homoiothermal animals show greater evidence of cyclical bodily changes than do birds. During moulting time, in the late summer and autumn, they shed their feathers and show other signs of depressed vitality, while in the spring, in preparation for the mating and breeding seasons, they put on fresh plumage and become extremely active. However, heat production, if not greatly increased in a short time, has no relation to body temperature.

As in the case of mammals, the temperature of the female was found to be slightly higher than that of the male of the same species and under the same conditions, in most cases, but in certain groups the opposite was found. For example, in the herons (Ardeidæ), in three species we have the following averages: Great blue heron (*Ardea herodias*), male, 104°·8 F., female, 103°·7 F. snowy heron (*Egretta candidissima*), male, 104°·8 F., female, 104°·0 F.; and the black-crowned night heron (*Nycticorax nævius*), male, 103°·5 F., female, 102°·6 F. Here there is a very pronounced difference in favour of the male, and the same is found in certain other shore birds.

Among other factors that influence the body temperature of birds it was observed that large masses of food, if cold, will frequently cause a sudden fall in temperature in a bird of small size, while bathing may produce a slight fall.

As in the case of mammals, nestlings and immature birds show a lower temperature and a wider variation than adults, due to the fact that the temperature control is less perfect. In a black-necked stilt (*Himantopus mexicanus*), one day old, a temperature as low as 95°·3 F. was recorded. Apparently this applies only to species with altricial offspring; it is not found in birds with precocial young, where the mechanism of temperature control is well organised at birth.

In considering the method of temperature control in birds, Mr. Wetmore believes, with Soum, that the air-spaces play an important rôle in the regulation of heat loss. On account of the feather covering and the absence of cutaneous glands, little heat is lost by radiation and evaporation from the skin. This throws an increased burden on the respiratory system, supplemented by the ostial spaces, and the regulation of heat loss through this channel is the chief factor in avian temperature control. The author brings forward some first-hand evidence in favour of this belief.

Discussing the significance of temperature control in general, the statement is made that "In the bird, the regulation of body temperature has reached its highest point, though birds stand second to mammals from an evolutionary point of view. Proof of this is found in the fact that birds have the highest body temperatures known, and that none of them hibernate." This conclusion scarcely seems justifiable on the evidence at hand. The degree of heat control of any species is not to be measured by the actual height of the body temperature, but rather by its diurnal variation, and according to this standard the regulation of body temperature appears to have reached its highest point in *Homo sapiens*, since the diurnal range in him is less than in any other so-called homoiothermal animal so far investigated, although the actual body temperature is among the lowest for mammals and far below that of any of the birds.

It is generally held that the higher the bird in the zoological scale, the greater is the body temperature. The author agrees with this statement, as a rule, but points out many discrepancies. If the appended tables be examined it will be noticed that, when arranged by families, the highest temperatures are found in pigeons, cuckoos, woodpeckers, and in the great passerine order beginning with the Tyrannidæ and ending with the Turdidæ. In five species of the former the average body temperature for male or female was 110° F. or more. The highest average temperature for both sexes was found in the western pewee (*Myiochanes richardsoni*) with a mean of 110°·2 F., the greatest single individual reading being 112°·7 F. Contrary to popular belief,

it was found that the swallows, as a group, possess the lowest average body temperature. In seven species examined in this family one alone, the rough-winged swallow (*Stelgidopteryx serripennis*), showed an average greater than 107°·5 F. Humming birds also, "with their tiny bodies seem to have a considerable range in temperature, but as a whole fall low in body warmth."

The volume is an important monograph, containing much valuable data, and it is a noteworthy contribution to this field of avian physiology.

SUTHERLAND SIMPSON.

Prof. Eddington's Romanes Lecture.

Pour comprendre Einstein. Par l'Abbé Th. Moreux. Pp. 245. (Paris: G. Doin, 1922.) 7 francs.

Die Grundlagen der einstein'schen Relativitätstheorie: Eine kritische Untersuchung. Von Prof. Dr. H. Strasser. Pp. 110. (Bern: Paul Haupt, 1922.) n.p.

Philosophy and the New Physics: An Essay on the Relativity Theory and the Theory of Quanta. By Prof. Louis Rougier. Authorised translation from the author's corrected text of "La Matérialisation de l'énergie," by Prof. Morton Masius. Pp. xv+159. (London: G. Routledge and Sons, Ltd., n.d.) 6*s.* net.

Le Principe de la relativité et les théories d'Einstein. Par Prof. L.-G. du Pasquier. Pp. xvi+511. (Paris: G. Doin, 1922.) 18 francs net.

Le Principe de la relativité et la théorie d'Einstein. Par Dr. Leon Bloch. (Bibliothèque des Annales des Postes, Télégraphes et Téléphones.) Pp. iii+42. (Paris: Gauthier-Villars et Cie, 1922.) 3.50 francs.

The Romanes Lecture, 1922. The Theory of Relativity and its Influence on Scientific Thought. Delivered in the Sheldonian Theatre, May 24, 1922. By Prof. A. S. Eddington. Pp. 32. (Oxford: Clarendon Press, 1922.) 2*s.* net.

ANOTHER collection of books and pamphlets reminds us of the hold which the theory of relativity has on the public imagination.

The Abbé Moreux gives his book the title "Pour comprendre Einstein," though he seems to consider that the effort to understand him is so much waste of time, for in his view the theory is both superfluous and misleading. Dr. Strasser, an anatomist with an amateur's interest in physics, gives us a critical discussion of the theory, but it is manifest that he has not come near to understanding it. Prof. Rougier, a philosopher who has read all about the new physics, sets out to tell us something of the influence of the theory upon philosophy, but leaves us with the impression of a shallow and ill-digested understanding of the development of physical science and tells us little about philosophy. Prof. du Pasquier and Dr. L. Bloch are less ambitious in their aims; they are content to be expositors and not critics. The results are correspondingly more successful and will probably be very useful to the French reader.

But among the books before us, the English reader naturally turns to Prof. Eddington's Romanes Lecture to hear the latest thoughts of one who has done more than any man living to establish and to popularise the general theory of relativity.

The lecturer impresses it upon his audience that it is stale news that the events around us form a world of four dimensions. There is, however, something that is new. It used to be customary for us to think of this four-dimensional world as having a definite set of sections, any one of which represented the state of the universe at a particular moment of absolute time, the whole being thus stratified in recognisable layers. But now this stratification has disappeared, there are no absolute time sections; it is only the individual observer who, to meet his own convenience, dissects the whole into "rashers," labelling each with the mark of an instant of his own consciousness. With a wealth of illustration and with language both grave and gay Prof. Eddington seeks to cure us of our egoistic outlook, and to persuade us to the wider view which finds truth, not in a particular picture of reality seen from one angle, but in a vision which includes and comprehends every possible picture. "It is only in this undissected combination of four dimensions that the experiences of all observers meet." On this we need scarcely dwell here, save to remind ourselves that the fault from which he would save us is one to which men in all ages have been prone, and not the least sinners have been those whose profession was the pursuit of exact truth. Yet we cannot help feeling that at times the preacher goes too far and so damages his case. To quote an illustration from the lecture. We allow an apple to fall. The moment the apple is released the earth begins to rush up to meet it. This is "the apple's view of things." "It is simpler than Newton's. We should regard it as on an equal footing with that of a terrestrial observer." This is very like asking an engine-driver to admit that it is quite natural to consider that when he admits the steam to the cylinder he sets not the engine but the whole universe in motion.

This is trifling however. Let us return to our destratified world of four dimensions. If we have been able to achieve this vision or to conceive of its possibility, we have grasped the essence of the doctrine of relativity, and we have come near to a superhuman view of history. The world is laid out before us as a changeless whole. Time and space are no more.

All is static. Dynamics has been resolved away. We can no longer ask about causes; that is to go back to the human point of view. We can simply gaze upon the scene and seek to catch some of its salient features.

So far as our present conceptions go, one of the most striking things about the picture will be that it is fibrous. The tangible part of it will be a great number of threads, one-dimensionalities. These represent electrons. Mere mortals think of them as moving points, but with our new vision we see them as continuous threads. These are chiefly present in bundles, twisted together into ropes; what are these? They are the material bodies of the mortals. One is an atom. Another, much more complex, is a man; another is a chair. The former in one part is gathering more threads to itself; in another part the threads unravel and dissipate. Such is life. In one part the chair-rope and the man-rope are in contact; the man is sitting on the chair. But of the behaviour of man as mortal the picture tells us little. We must become mortal and see only sections of the picture before we can see him as a living being with an unfolding consciousness. If the poet and the mystic do indeed aspire to free themselves from the fetters of time and space, as we read in the concluding passage of the lecture, we fear that they will find but little left either of poetry or of mystery in the world after which they yearn.

But, leaving the poet aside, and returning to the physicist, what is left for him in the great synthesis of all science into the one map of all events? What becomes of his vocation of measurement? As Prof. Eddington emphasises again and again, he too, with all his experiments, is in the picture. His rules, scales, clocks, photographic plates are all there; their whole history is depicted. All his experiments of measurement are represented by the passage through the picture of the threads that represent the marks on the scales, meeting and intersecting the threads that represent other particles of matter. The four-dimensional picture itself is not to be measured. It contains within itself the process of measurement in the ordinary three-dimensional world and all the results are recorded for us to read. We have no four-dimensional scale which we may move about and apply to different parts of the picture for the sake of comparison. We merely stand, look, and try to read what we see.

Perhaps Prof. Eddington does not see the picture quite in this way. Perhaps the "world" for him is a four-dimensional continuum in which our threads are merely lines of singularity. He seems to contemplate as "measurable" the intervals between pairs of points in this continuum which do not correspond to events in the history of any particle or electron in the material universe. But we wish to ask him how these intervals are in practice to be measured. He says, "When we have mastered the geometry of the world we shall have inevitably learnt the mechanics of it." That is so. A complete description of the world lines of all particles necessarily tells us all about the phenomena of motion.

But to master the geometry of the world means to describe its main features by means of a few simple propositions. In Prof. Eddington's view, the process consists in measuring all the intervals between all pairs of neighbouring events, and then in examining whether these intervals will fit together in an Euclidean fashion, or in a particular type of non-Euclidean scheme. If we discover that they will fit in a recognised and manageable mathematical scheme, we have mastered the geometry of the world.

But we ask again how are these intervals to be measured. Since all measurements are contained in the picture, and since for the description of the picture event by event no system of intervals is necessary, the whole of our experimental measurements have nothing at all to do with a scheme of intervals, and any geometrical system whatever may be used for the purpose of attaching intervals. What, then, is it which discriminates between Einstein's system and any other possible one? It is simply this, that if we adopt that system, the facts of the motions of particles or of the propagation of light can be expressed in a very simple form. The path of Mercury, for instance, is a geodesic. Possibly this fact may be further analysed and shown to follow from the configuration of the electron being spherical. But in any case we cannot measure the tube which would represent such an electron in the super-world of four dimensions.

Thus Einstein's law of gravitation, by itself, is not a statement about the world at all. It is only when it is taken in conjunction with some other hypotheses, such as that the path of a particle is a geodesic, that it predicts anything, and becomes capable of experimental test. The world itself cannot be said to be either Euclidean or non-Euclidean, for it does not furnish us with definite values for the intervals between all pairs of events in the continuum. We may say that the world-phenomena are more simply described on the basis of a non-Euclidean system than on a Euclidean system; but it is surely not allowable to go further and say that this is "because the world is not a Euclidean or flat world." Prof. Eddington would perhaps reply that for him the world is nothing more than the measurements that we make of it, and that these measurements do not fit in a Euclidean scheme. But this brings us round again to the same question, what is meant by measurements of the four-dimensional whole? We would ask our lecturer to give us a sequel

to this discourse in which, assuming the four-dimensional presentation, he would state explicitly, either in general terms or by precise illustration, how he would compare the intervals between any two pairs of events.

E. CUNNINGHAM.

The Marketing of Whole Milk.

The Marketing of Whole Milk. By Dr. H. E. Erdman. (The Citizen's Library: Marketing Series.) Pp. xvi+333. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 21*s.* net.

THE recent disputes concerning the price of milk have again shown how difficult the problem has become under modern conditions, more especially in the large towns. The farmer is no longer able to take his milk direct to the consumer except in the case of a village or small town, and there has arisen a class of dealers or distributors who occupy the place of the middleman. Some of these distributors are large companies with the command of much capital, and their powerful organisations have led to something very like monopoly. The producers, on the other hand, have also organised themselves, and a struggle between the two parties has recently ended. In the volume under notice, this question as it appears in the United States is very completely analysed, and Prof. Erdman, who is an economist, has dealt with it more fully and critically than has previously been attempted. After discussing the peculiar position occupied by milk as a foodstuff, and the regulations which the public health authorities of all civilised countries have imposed, the author takes marketing and distribution, instances what has been done in the past and states the present position. The part played by the middleman and dealer is made clear, and the rise of collective bargaining is illustrated by the action of the Orange County farmers in their successful fight with the New York dealers in 1883, which may be regarded as the beginning of what has now become the general practice in the large American cities. The strike—or better the boycott—has been the weapon of the producers, and experience has shown that it is two-edged, owing to the difficulty which the farmer has in disposing of his milk—a perishable commodity—except by making it into cheese or butter or, at worst, by feeding it to stock, all of which courses are seldom remunerative. It is made clear that the producers must also submit to regulations governing their combined action, otherwise the results are doomed to failure.

Other matters dealt with are the difficulty of arriving at the cost of milk, owing to the position of the farm, the ability of the farmer, the proximity to market, and so on, and it is laid down that the method of arriving at a basic price can only be a starting-point in negotiations.

This book, which makes a strong appeal to the general reader, will be of interest to all concerned in the milk trade, whether as producers, distributors, or consumers, and it should lead to what the author regards as the only solution of the difficulty—"a better understanding all round."

Our Bookshelf.

Proceedings of the London Mathematical Society. Second Series. Vol. 20. Pp. liv+502. (London: F. Hodgson, 1922.) n.p.

THE present volume of the London Mathematical Society's Proceedings is the fifty-fifth issued since the foundation of the society and the twentieth in the present (large octavo) series. Like the preceding volumes issued by the society, it consists mainly of papers which embody original investigations on various mathematical subjects. Many of the papers, of which there are nearly forty, will appeal only to a limited class of reader. In mathematics, even more than in other sciences, the results of new investigations are apt to appear abstruse to the lay mind. The solution of a cubic equation, the Newtonian theory of gravitation, even the elementary applications of the calculus, fundamental and well known as they are now, were not familiar to the world, or even to the general run of university students, for many years after their discovery. By providing facilities for the publication of these specialised researches the London Mathematical Society has earned the deep obligation of the English mathematical world. Practically all the society's income is expended in producing its Proceedings, and, in view of the increased cost of printing, a large membership is essential to provide adequate funds. Inasmuch as every man is a debtor to his profession, every English mathematician should help to further the work of the society by becoming a member.

In the volume under review the articles most likely to appeal to the general reader are the excellent obituary notices of the late Lord Rayleigh and Herr Adolf Hurwitz, written by Profs. Lamb and Young respectively. There is also printed a presidential address on "Some Problems in Wireless Telegraphy" by Prof. Macdonald. Of the more technical papers it would be invidious to single out any one for special mention. The society insists on a high standard of excellence in everything it prints, and the inclusion of a paper in the Proceedings is a sufficient guarantee of quality. We notice that there is an almost entire absence of pure geometry from the present volume. Can it be that research in this subject is no longer encouraged in England?

The method of indexing each individual volume of the Proceedings leaves nothing to be desired. A subject index to the first thirty volumes of the first series was issued many years ago. We suggest that the time is approaching when the Council should consider the desirability of publishing a further subject index to the later volumes.

W. E. H. B.

A Laboratory Manual for Comparative Vertebrate Anatomy. By Libbie H. Hyman. Pp. xv+380. (Chicago: University of Chicago Press, 1922.) 2.50 dollars net.

THIS work is the outcome of a particular course of practical lessons conducted by its author. The disability which such an origin fastens upon a book is well known to every teacher of zoology, and Mr. Hyman's book is no exception to the rule. It suffers from the conditions of its birth—not that these, though American, were insalubrious, but that they were so highly specialised as to limit greatly the adaptability of the offspring. Nevertheless the care that has obviously been taken by the author, and his ability in presentation, should make his book useful even in our small cis-Atlantic schools of zoology, where a somewhat more elastic course of instruction is possible than that provided at Chicago.

Mr. Hyman rebels against the tyranny of the type system, and uses the comparative method of study in his laboratory. His chapters describe in succession the systems of organs of the Vertebrata as exemplified by Elasmobranchs (Mustelus, Acanthias, Raja), Urodeles (Necturus), a Chelonian, the pigeon, the cat, and the rabbit. The instructions for dissection are clear and sufficient; and an attempt is made to bridge the gulf which commonly yawns between the principles of the lecture room and the observations of the laboratory, by supplying an accompaniment of morphological comment in the form of introductions and summaries to the chapters. This device and the general nature of the first four chapters disguise—but do not dispose of—the evils of the type system, which are perpetuated in spite of the author's dismemberment of his types and the wide dispersal of their remains throughout the book.

Only one notable omission has been detected: Mr. Hyman's classification of the Chordates—two pages in length—ignores the Dipnoan fishes, nor in the whole of his book do they once appear, though the thesis often plainly demands them.

A pronouncing glossary forms a valuable appendix, though we fear its phonetics will not be acceptable to English ears. H. G. N.

Studies in the Theory of Human Society. By Prof. F. H. Giddings. Pp. vii+308. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1922.) 14*s.* net.

PROF. GIDDINGS points out that in science this century has been a time of rectification rather than of great discoveries. This applies particularly to the fundamental conceptions of sociology. These "Studies," which are always suggestive, frequently provocative, and in more than one instance illuminating, are a contribution to the revision of the theory of human society necessitated by the increased clarity and precision in scientific vision which has come about in the last twenty years. Their somewhat discursive character makes it difficult to give a concise account of the author's achievement in this direction; but, in brief, it may be said to lie in the application of a psychological interpretation to the conclusions of writers such as Darwin, Spencer, Bagehot, and Kidd, to name the more important, thereby accounting for social origins and the stages in the evolution of society in terms of the struggle for existence. Prof. Giddings's theory of human society is that social phenomena are a product of stimulus reacted to by "pluralistic" behaviour, giving rise to consciousness of kind—the "herd instinct" of other writers—from which are derived discriminating association, the ethical code, co-operation and division of labour, and, in the long run, selection and perpetuation of the adequate—the "fit" of an older terminology.

The Chemical Examination of Water, Sewage, Foods, and other Substances. By J. E. Purvis and T. R. Hodgson. (Cambridge Public Health Series.) Second and enlarged edition. Pp. viii+346. (Cambridge: At the University Press, 1922.) 20*s.* net.

IN this edition the authors have expanded the chapters on water and milk, given more details on the analysis of foods and beverages, and added "an outline of elementary toxicological analysis." A very good feature is the inclusion of plenty of typical analyses. The book will be found very valuable to students preparing for the examination of the Institute of Chemistry, and can be recommended as a useful introductory treatise. Although the quoted results of water analyses are given with the acids and bases combined, there is no indication as to how the necessary calculations are to be made, and some of the sections are so condensed that it is doubtful if they are of value. A great drawback to the utility of the book is its high price.

Modern Chemical Lecture Diagrams, with Uses and Applications fully described. By Dr. G. Martin, assisted by J. M. Dickson and Maj. J. W. Christelow. Pp. 88. (London: Sampson Low, Marston and Co., Ltd., n.d.) 3*s.* 6*d.* net.

THE purpose of this book is not clear. The illustrations are found in most text-books with adequate descriptions—those supplied in the present work are often too brief to be of any service, as "Fig. 5 shows how these tubes were experimented with by Andrews and Tait." Many of the diagrams represent apparatus far from "modern." The only calorimeters illustrated are those of Favre and Silbermann; chromium is prepared by Fremy's method; sulphuric acid is concentrated in glass retorts, etc. In some cases the descriptions are faulty: Bunsen's eudiometer is ascribed to Cavendish; the Almaden process for the manufacture of mercury is called "*Distillation* of mercury," etc. As a work of three authors a more modern result might have been expected.

Forensic Medicine and Toxicology. By Dr. J. Dixon Mann. Sixth edition, revised throughout. By Dr. W. A. Brend. Pp. xi+573. (London: C. Griffin and Co., Ltd., 1922.) 30*s.*

THE sixth edition of Dixon Mann's "Forensic Medicine and Toxicology," which ranks among the foremost English text-books on the subject, is the second to be edited by Dr. William Brend. It has undergone a revision which brings it completely up-to-date; a larger page is used than in previous editions, and the number of pages is reduced. The section on insanity has been rewritten on the basis of modern psychiatrical views; and that on toxicology gives additional information on poisoning by salvarsan, tetrachlorethane, T.N.T., and the gases of warfare, and on the infections formerly ascribed to ptomaine poisoning.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Relativity and Physical Reality.

IN a review by Prof. H. Wildon Carr entitled "The New Way of Thinking Physical Reality," which appeared in NATURE of October 7, p. 471, the writer (speaking of a work by Prof. Léon Brunschvicg) says regarding physical reality: "According to Einstein, we cannot say, speaking absolutely, that there is any picture even for God."

It seems to follow from this that not even the Almighty himself could understand the theory of relativity. If this be so I cannot help thinking that the fault lies with the theory of relativity and not with the Almighty.

The writer then proceeds to say: "The picture is only known as a function of the frame. That is, the things measured are only known through the measurings, and the measurings are bound up with the things they serve to measure."

This seems to imply that measurement is the fundamental thing to be considered in space-time theory, and with this I am not in agreement.

In my book, "A Theory of Time and Space," published in 1914, I showed that the ideas of measurement could be built up from the ideas of *before* and *after*, which were regarded as absolute and not dependent on any particular individual.

In my smaller book, "The Absolute Relations of Time and Space," I gave an abbreviated account of this work and added an appendix showing how the various complicated geometries which are treated of in Einstein's generalised relativity could be obtained by means of a modified measure of interval.

However, most relativists have been too busily engaged in praising Einstein to spare the time to go into my work.

One result of this has been that, by taking the idea of measurement as the fundamental thing, a very large number, if not the majority, of relativists have fallen into the very serious error of asserting that the length of what they call a "world-line" is a minimum between any two points of it. In my "Theory of Time and Space" I showed (p. 360) that this is not correct.

Finding that a number of writers were making this mistake, I wrote a letter which appeared in NATURE (February 5, 1920, p. 599) in which I invited attention to this matter and pointed out that in what I called "inertia lines" the length, so far from being a minimum, was actually a maximum in the mathematical sense; while, in what I called "separation lines" the length was neither a maximum nor a minimum.

In this letter I gave actual numerical examples to illustrate these points. I invited attention to the matter again in my "Absolute Relations of Time and Space" (p. 71), published in 1920.

In spite of these efforts of mine, I again find this blunder cropping up in works published this year. Now it seems to me that it is a very important point since, in ordinary geometry, there is no such thing as a "longest" line joining two points.

The idea would, I think, be apt to cause bewilderment in the mind of a person meeting it for the first time, unless it were properly presented to him. The idea of a "straight line" which was neither a maximum nor a minimum would, I fancy, cause even greater bewilderment, and he would wish to know how such lines were to be defined.

In Einstein's generalised relativity, the element of interval is taken as a starting-point, although the idea of an interval in the minds of many writers is so obscure that they ascribe a minimum property to it which it does not possess.

Although I have tried so often to impress on relativists that the ordinary method of treating space-time theory is unsatisfactory, I propose to make one more attempt to show that the measurement of intervals is not the simple thing that is so often supposed.

Let us consider the simple time-space theory in which the length of an element ds of what I call a "separation line" is given by the formula:

$$ds^2 = dx^2 + dy^2 + dz^2 - dt^2.$$

Let O be the origin of co-ordinates and let P be any point on the axis of x, at a distance l from O, measured, say, in the positive direction.

Let $F(x)$ be any arbitrary differentiable function of x which is continuous and single valued, and which is equal to zero for $x = O$ and for $x = l$.

Now consider the space-time curve the equations of which are:

$$y = t = F(x),$$
$$z = o.$$

It is evident that this curve passes through O and P.

But now we have

$$dy = dt,$$
$$dz = o,$$

and so $$ds^2 = dx^2.$$

Thus we have $ds = dx$, and so the length measured along the space-time curve from O to P is equal to the length from O to P measured directly along the axis of x. That is, it is equal to l.

Thus a space-time curve the equations of which contain an arbitrary function can have the same length between two points as the direct length measured between those points.

ALFRED A. ROBB.

October 11, 1922.

The Miraculous Draught of Fishes—an Explanation.

WE have in the Gospel according to Saint John, in his twenty-first and last chapter, an account of the miraculous draught of fishes in the lake of Galilee for which modern research into the habits of the Galilean fishes offers a perfectly reasonable explanation. The account is as follows:

"Simon Peter saith unto them [certain of the disciples], I go a fishing. They say unto him, We also go with thee. They went forth, and entered into a ship immediately; and that night they caught nothing. But when the morning was now come, Jesus stood on the shore. . . . Then Jesus saith unto them, Children, have ye any meat? They answered him, No. And he said unto them, Cast the net on the right side of the ship, and ye shall find. They cast therefore, and now they were not able to draw it for the multitude of fishes."

Simon Peter then girded his fisherman's garment around him and leaped overboard. But the other disciples brought their boat to shore dragging the net full of fishes with them. Further on we read: "Simon Peter went up, and drew the net to land full of great fishes, an hundred and fifty and three: and for all there were so many, yet was not the net broken."

The explanation of this is to be found in a study of the habits of the fishes living in the lake of Tiberius or

Galilee. These fishes are perch-like in form and affinities, so much so that the average American angler, especially if a small boy, would call them perches. However, ichthyologists to-day place them in a family called Cichlidæ, though they were formerly called Chromidæ. By one name or another, accounts of them may be found in systematic works on fishes.

The first ichthyologist to study these fishes in their habitat was L. Lortet, who made trips to the Holy Land in 1875 and 1880, and in 1883 published an extensive memoir based on the results gained at first hand. Lortet says[1] (p. 106):

"The fishes of the lake of Tiberius, very good to eat, serve as a pasturage for the myriads of crested grebes (*Podiceps cristatus*) and of pelicans. Frequently the grebes snatch at the eyes of the chromids, and with one stroke of their long sharp beaks lift out as cleverly as would a skilful surgeon the two eyeballs and the intro-orbital partition. These unhappy fish, now blind, of which we have taken numerous examples, have thus the entire face perforated by a bloody canal which cicatrises rapidly. It is only the larger individuals who are thus operated on by the grebes, for, not being able to avail themselves of the entire fish, these voracious birds take the precaution to snatch only the morsel of their choice."

The explanation of this we find on his next page, where we are told that these chromid fishes habitually swim at or near the surface of the water.

Canon H. B. Tristram made collections of fishes in the sea of Galilee in 1864, thus antedating Lortet by eleven years, but his book, "The Survey of Western Palestine. The Fauna and Flora of Palestine," was not published until 1884 by the Palestine Exploration Fund.[2] On page 164 he refers to the Chromidæ as found in the lake of Galilee in "amazing multitudes" and continues:

"All these Chromidæ are frequently found with their eyes extracted, and their foreheads pierced by the Grebes, which prey on them, but they seem to thrive perfectly well in spite of this mutilation, and to flourish in a state of absolute blindness."

Of *Chromis tiberiadis*, the most abundant form, Canon Tristram[3] writes:

"I have seen them in shoals of over an acre in extent, so closely packed that it seemed impossible for them to move, and with their dorsal fins above the water, giving at a distance the appearance of a tremendous shower pattering on one spot of the surface of the glassy lake. They are taken both in boats and from the shore by nets run deftly round, and enclosing what one may call a solid mass at one swoop, and very often the net breaks."

Dr. E. W. G. Masterman,[4] in chapter 2, "The Inland Fisheries of Galilee," of his book, "Studies in Galilee" (Chicago, 1909), thus describes the ordinary activities of the fishermen of the lake of Tiberius: ". . . their movements being directed by a man stationed on a point of the shore high above the water, who from his vantage ground is able to detect the presence of a shoal of *musht* (Chromids)." The fishermen, proceeding to the point indicated by the look-out, quickly run a net around the school. However, he tells us that the bottom everywhere is obstructed with large stones, and that the fishermen have continually to dive to free the net. This is possibly if not probably the explanation of Peter's leaping ovebroard.

From the excerpts given, it is plain as to the purport of the proffered explanation, if in the East, where customs change but slowly, we may interpret the past in terms of the present. Fish which go in schools at the surface of the water; fishermen who have not yet struck a school; Jesus on high ground looks over the lake, sees a school and points it out to the fishermen; they cast their nets in the direction indicated and draw them in full to the breaking point.

E. W. GUDGER.

American Museum of Natural History,
New York City, Sept. 27.

[1] Lortet, L. "Poissons et reptiles du lac Tibériade, etc.," in his "Etudes Zoologiques sur la fauna du lac Tibériade, etc." Archives Museum Histoire Naturelle de Lyon, 1883, vol. 3.

[2] The Palestine Exploration Fund is interdenominational in its organisation and sources of income. It has H.M. King George V. for its patron, and is supported by voluntary subscriptions. Its purpose is the thorough study of the archæology, geology, geography, history, natural history, etc., of Palestine.

[3] Dr. H. B. Tristram, Canon of Durham Cathedral, because of ill-health (lung trouble) lived in Algeria during the winters of 1855–1857. He went to Palestine in 1860 and remained for some years studying the fauna and flora, the resulting data being incorporated in his 455-page quarto volume, the standard work on the natural history of the Holy Land. In 1879 he was nominated for but declined the Anglican Bishopric of Jerusalem. He was the author of seven books on Palestine.

[4] Dr. E. W. G. Masterman is, and has been for a number of years, honorary general secretary of the Palestine Exploration Fund in Palestine.

Arabic Chemistry.

i. MAY I be allowed to direct the attention of those interested in the history of chemistry to an important paper by Prof. Eilhard Wiedemann of Erlangen? It is entitled "Zur Alchemie bei den Arabern" and is published in Heft V. of the "Abhandlungen zur Geschichte der Naturwissenschaften und der Medizin," Erlangen, 1922. It contains a translation of the passage concerning alchemy in the "Kashfu'l-Zunūn" of Hajji Khalifa, with many biographical details of the chemists mentioned. Several of these details have been provided by Prof. Brockelmann, the author of the monumental "Geschichte der arabischen Litteratur," and are entirely new. There is also a list of the most important works (with a few extracts) of the famous Aidamir al-Jildakī († 1361).

It is perhaps ungenerous to offer any criticism of so useful a contribution to chemical history, but I feel that Prof. Wiedemann's explanation of *'ilm al-mīzān* (science of the balance) as *Beziehung und Abwägung des richtigen Masses* should not be allowed to go unchallenged. As I have pointed out in the current number of *Science Progress* (October 1922), the term "Science of the Balance" as applied to alchemy refers to the proper adjustment of the *qualities* of a substance, that is, its hotness and dryness, etc., and is not used in a quantitative sense, even by Al-Jildakī, and certainly not by Jābir ibn Ḥaiyān, who, I believe, originated it.

A work by Al-Jildakī which seems to have escaped the notice of Prof. Wiedemann is "Zahru'l-Kimām," a commentary on an alchemical poem ("Qaṣīdatu'l-Nūniyya") of Abu'l-Aṣba' 'Abdu'l-'Azīz ibn Tammām al-'Irāqī (wrongly named Abu Casba by Berthelot, "La Chimie au Moyen Age," tome iii. p. 4). Ibn Tammām al-'Irāqī was a contemporary of Al-Jildakī, who thought very highly of him.

ii. Berthelot (*op. cit.* p. 5) says, "Plusieurs des auteurs alchimiques arabes ont été traduits en latin, aux XII^e et XIII^e siècles, et ces traductions existent en manuscrit dans les grandes bibliothèques d'Europe. Un certain nombre d'entre elles ont même été imprimées . . . dans les collections intitulées *Theatrum chemicum*, *Bibliotheca chemica* (*etc.*). . . . A côté d'œuvres authentiques, je veux dire réallement traduites ou imitées de l'arabe, telles que la *Turba*, les écrits attribués à Rosinus, Morienus, Avicenne, etc., il en existe d'autres, fabriquées de toutes pièces en Occident, comme les prétendues œuvres des faussaires latins qui ont pris le nom de Géber."

The first part of Berthelot's statement is undoubtedly correct, although Berthelot himself was not able to discover the Arabic texts of any of the works he mentions as of probable Arabic origin.

Perhaps, therefore, the following facts will be of interest.

(*a*) In a work entitled "Knowledge Acquired concerning the Production of Gold," an edition of the text of which, with a translation, I have in the press (Geuthner, Paris), the author, Abu'l-Qāsim Muḥammad ibn Aḥmad al-'Irāqī, quotes several passages which he attributes to Marianus (Morienus, *supra*), the teacher of Khālid ibn Yazīd. Many of these passages occur in the Latin "Liber de Compositione Alchemiae," ascribed to Morienus, which is to be found on pp. 509-519 of vol. i. of Mangeta's "Bibliotheca Chemica Curiosa" (1702).

(*b*) On p. 217 of vol. ii. of the latter treatise is a work entitled "Epistola Solis ad Lunam crescentem," which begins, "In tenuitate enim nimia dabo tibi de pulchritudine mea lumen." This work is strongly Arabic in atmosphere, and is apparently a translation of the "Risālatu'l-shams ila al-hilāl" (Letter of the Sun to the New Moon) written by Abu 'Abdullah Muḥammad ibn Umail at-Tamīmī, who lived in the second half of the third century after the Flight (*ca.* A.D. 900). There is a manuscript of this work, with a commentary by Al-Jildakī, in the British Museum (*Add.* 23,418, xvi.). The Latin line quoted above is an exact translation of the first line of the Arabic poem; I have not yet seen the MS., so that I cannot say whether the agreement between the "Epistola" and the "Risāla" holds throughout.

The second part of Berthelot's statement, namely, that in which he expresses his opinion that Geber's works are forgeries, opens a question too wide for discussion here. I would point out, however, that Berthelot examined less than a dozen of the Arabic works of Jābir ibn Ḥaiyān, and as the latter is said to have written more than 500 books Berthelot was perhaps a little premature. Jābir, in his "Book of Properties" (a manuscript of which is preserved in the British Museum), refers to another book of his called "The Summary," which may possibly be the "Summa" of Geber. There is, moreover, in Mangeta (vol. i. p. 562) a work entitled "Testamentum Gebri"; now a commentator of Jābir's "Book of Mercy" refers to the same author's "Kitāb waṣiyya mautihi," or "The Book of his Last Will and Testament."

Evidence of this and other sorts is gradually accumulating, and it would not surprise me to find that Geber and Abū Mūsā Jābir ibn Ḥaiyān were, as for so many centuries they were held to be, one and the same.

E. J. HOLMYARD.

Clifton College, October 9.

On the Occurrence of the Archiannelids, Saccocirrus and Protodrilus, on the South and West Coasts of England.

IN NATURE (vol. 91, pp. 85 and 348) the present writer recorded in 1913 the occurrence—for the first time in England—of abundance of Protodrilus in many situations, and a few Saccocirrus in one situation near Plymouth, and it was shown that both these forms have the curious preference for situations near high-water mark where fresh water trickles through or over the foreshore at low water, but covered by sea water at high tide (*l.c.* 348). Since 1913 the writer has searched for and found Protodrilus in similar situations and in a large number of places between Salcombe and Falmouth, and this year was successful in taking the same animal at two places on the west coast of England, namely, on September 7, near high-water mark where the Wanson (so-called) river runs into the sea at the south end of Widemouth Bay near Bude. (See Ord. Survey Map, 1 in. to mile, river Torridge, Sheet 127, 1H, 47-53), and on September 22 in a similar situation on a beach—formerly well known for shells—at Woolacombe (see O.S. Map, 1 in. to mile, Barnstaple, Sheet 119, 4C, 16-02).

In 1917 and on various occasions since, the writer has also taken large numbers of Saccocirrus (*e.g.*, 80 from a hole in the gravel about 1 ft. by 1 ft. deep in half an hour) on a beach at Portwrinkle in Whitsand Bay (see Ord. Sur. Map, 1 in. to mile, Plymouth, Sheet 148, 5F, 83-15) in a position exactly similar to that described formerly (*l.c.* p. 348). This year a few individuals were also taken in the gravel on the above-mentioned shell-beach at Woolacombe. Protodrilus and Saccocirrus therefore probably occur in all suitable situations in the south-west of England, and may no doubt be recorded—after search in suitable places—from a much more extended area in the British Isles. The specimens of each genus from all localities belong respectively to one species, so far as can be gathered from external characters, namely *Protodrilus flavocapitatus*, and an apparently new and as yet undescribed species of Saccocirrus. It is hoped that the characteristic restless side-to-side movement of the head and anterior region of Saccocirrus may shortly be portrayed by cinematograph.

Living in about the same situation as Protodrilus and Saccocirrus is almost always found the planarian *Gunda ulvae*. This planarian is large and easily found under stones in pools, and therefore serves as a guide in the search for the archiannelids. The apparent positive geotropism of Gunda, which is probably true, is an interesting phenomenon and not well known; if a number of the planarians be taken on a flat stone, they can be made to change direction a large number of times by holding the stone vertically towards the light and turning it repeatedly through an angle of 180°.

The occurrence of the above-mentioned animals only in the peculiar habitat where the water undergoes violent fluctuations in salinity suggests the presence of an undetected special food supply.

J. H. ORTON.

Marine Biological Laboratory,
The Hoe, Plymouth,
October 10.

Origin of the Name of the Genus Masaris.

IN Ed. André, "Species des Hyménoptères d'Europe et d'Algérie," vol. ii. p. 829, it is stated that the derivation of the name "Masaris" is unknown. The first species described under this genus is *M. vespiformis* F., from Egypt; it also occurs in Algeria.

May I suggest that the origin of the name is the Arabic name for Egypt, "Masr" (also used colloquially for its capital, Cairo). As a common noun "masr" means "a fortified place," and its plural is "amsar"; the word is connected with the Hebrew word rendered "Mizraim" in Genesis. It has long seemed to me that this derivation is at least probable, and I should be glad to know if any other has been suggested.

E. W. ADAIR.

Turf Club, Cairo, September 26.

FABRICIUS, 1793, "Ent. Syst." ii. p. 283, in founding the genus Masaris, did not indicate any derivation for the name, and L. Agassiz, 1845, "Nomencl. Zool. (Hymenoptera)," masks his inability to give a derivation by the suggestion that Masaris is a proper name.

F. A. B.

American Research on Acoustics.

By ALAN E. MUNBY.

THE Wallace Sabine laboratory of acoustics, a photograph of which is here reproduced (Fig. 1) is situated at Geneva, Illinois. It is a three-story building of brick and concrete specially erected for its purpose and forms a unique design, consisting of two structures under one roof, an inner room or sound chamber completely insulated from an outer shell. Figs. 2 and 3 show a plan and section of the building, the main feature of which is the sound chamber 27 ft. by 19 ft. and 19 ft. 10 ins. high. Here the original intensity of the sound is measured. The walls of this chamber are of 18-inch brick coated with cement outside and with wood fibre plaster inside, and the room as shown in the section has a separate concrete foundation. From this room half-way up

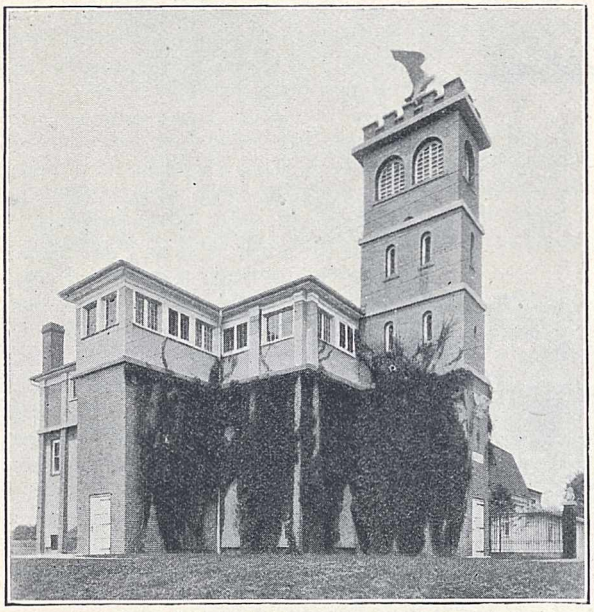

FIG. 1.—Riverbank laboratories, Geneva, Illinois.

its walls three small testing chambers are provided furnished with heavy steel doors to exclude sound completely. Materials to be tested are placed across these chambers, when the doors are opened to admit sound from an organ in the sound chamber. The organ is a complete 73 pipe instrument giving all the tones of the musical scale from C 64 to C 4096. It is operated electrically by the observer, who notes the time before a sound becomes inaudible in the test chamber. To ensure equality of sound distribution in the sound chamber a large steel reflector mounted on a central shaft is made to revolve in the room on a vertical axis. The main work, up to the late Prof. Sabine's death, has been connected with the calibration of the sound chamber and its instruments. This laborious undertaking completed, the activities of the laboratory should rapidly command a wider interest.

The present director of the laboratory, Prof. Paul E. Sabine, has recently published the results of an investigation on the nature and reduction of noises as occurring in business offices. Scarcely anything has been done in the way of investigation on the subject of noise, though the topic is obviously of wide interest. Prof. Sabine begins by pointing out that the sound-absorbing qualities of any material vary widely with pitch, and instead of attempting to apply data obtained for musical sounds, he wisely deals with the matter *de novo*, taking the actual sources of sound, such as the click of a typewriter, as the source for experimental purposes. A distinction is drawn between sounds in the open air and those in which reflection takes place, as in a room, from the point of view of the effect of the noise of one operator upon another. All but two or three per cent. of sound waves falling on a hard plaster wall are reflected, and in an experiment cited there were found to be 500 reflections before a given sound reached final decay. It would seem, therefore, that as much absorption as possible by walls and ceilings should be aimed at to prevent these reflections.

An important point brought out by these investigations is that the absorption efficiency of a given material for both musical sound and noise is greater when the material is employed in small units. In discussing practical measures Prof. Sabine alludes to linings of felt for walls, covered with some fabric, to light porous tiles and plaster, citing a plaster recently developed which is a much better absorber than ordinary plaster. He even makes a distinction between painted and unpainted walls, the general tendency of paints being to fill up a porous surface and thus decrease sound absorption, and numerical data are given showing the relative value of various surfaces in absorbing the sound of a typewriter. In these experiments the difference of power of absorption of a given material for various sounds, though existing, was found to be small.

Prof. Sabine has made a separate and special investigation of the absorption of sound by rigid walls and finds that the refraction effect on the passage of the sound into the new medium is of only trifling importance. His experiments have recently been further extended to tests upon artificial aids to hearing. He classifies the types of instruments commonly used and describes investigations to measure the difference of times during which residual sound may be heard with and without a particular instrument as a measure of the increase in loudness produced by that instrument. His results are illustrated graphically. It was observed that the highest tones in every case were less loud with instruments than without, suggesting that the short wave lengths enter the small cavity of the external ear better than do the air columns of instruments. With certain instruments also the lowest tone (frequency 128) was less well heard than without their aid. Prof. Sabine does not consider the prospects of improvements in alleviating extreme deafness to be good, but points the way by reference to the amplification of telephone currents by the thermionic tube, and he suggests a joint attack on the problem by physicists and physiologists.

Another series of experiments on sound-proof parti-

tions has recently been conducted by Mr. F. R. Watson, also of Illinois University, which are described in Bulletin No. 127 of the University. The results have led to conclusions somewhat at variance with generally accepted ideas.

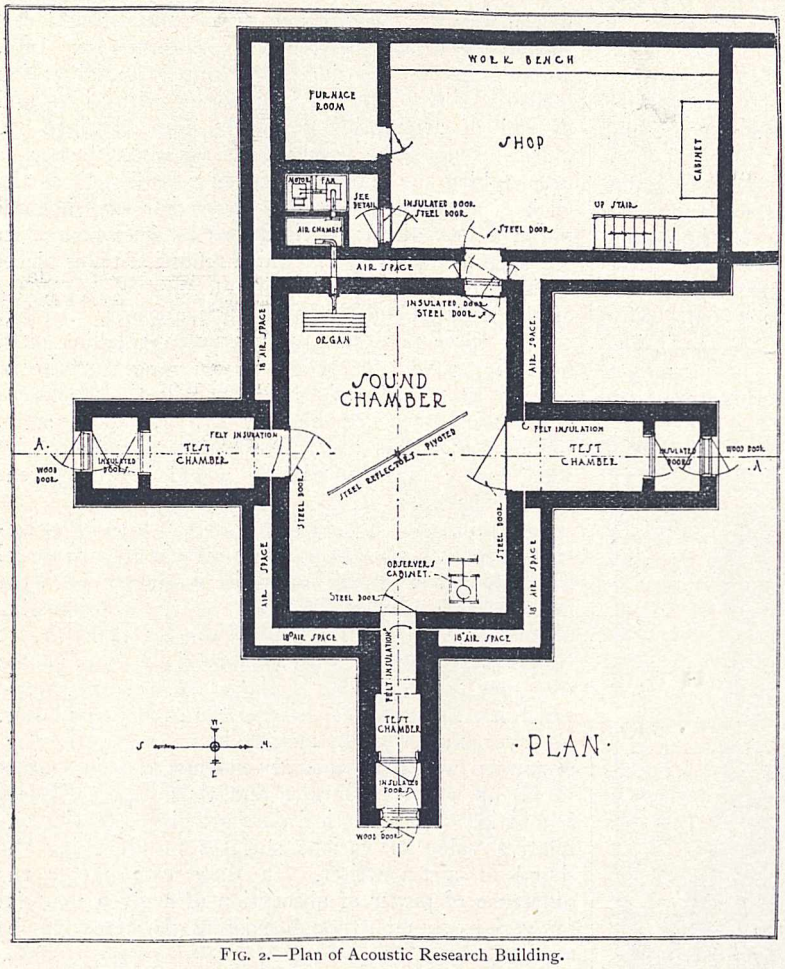

FIG. 2.—Plan of Acoustic Research Building.

Sound, on striking an object, is reflected, absorbed, or transmitted, and usually all three results occur. In any particular case a definite amount of energy has to be got rid of in these ways, and for sound-proofing one may aim chiefly at reflection or absorption. When sound waves in one medium encounter another medium having a different density, the progression of the waves is disturbed, a certain amount of reflection takes place, some of the energy is absorbed, that is, converted into heat, while the amount transmitted through the medium will depend on its thickness and properties, such as porosity and rigidity.

In practice the materials used to separate rooms or buildings are usually of a complex character, and their rigidity will depend not only on their nature and thickness, but on the area of the separating wall. Hence the problem of assessing sound transmission is a very complex one. The author of the bulletin cited directs attention to the very detrimental effect as regards sound insulation of even small apertures caused by ill-fitting doors or by ventilators; he also makes a distinction between sounds due to air waves striking a separating medium and vibrations such as those caused by machinery, the former best resisted by heavy and rigid walling, the latter by arranging for absorption of the vibrations by beds of sand or like loose material.

From a useful résumé of previous experiments on sound transmission, the conclusion is drawn that rigidity is a deciding factor in sound prevention, and some experiments recently conducted by Prof. P. E. Sabine are cited which showed that a plate of glass three-sixteenths of an inch thick transmitted less sound than two glass plates with a sheet of celluloid sealed between them of the same total thickness. A series of tests made at the Music Building, Chicago, in 1895, is quoted, which tends to show that an air space between materials forming the two sides of a partition is of much less value for sound prevention than is commonly supposed, and that benefits which accrue from such space are almost wholly negatived by the inevitable connexion at intervals for structural reasons between the two sides.

In Mr. Watson's experiments use was made of the Rayleigh disc resonator, which admits of much more accurate and comparable results than are possible by aural comparisons adopted by many earlier experimenters. A very large number of materials were tested, and these were in all cases of satisfactory area—

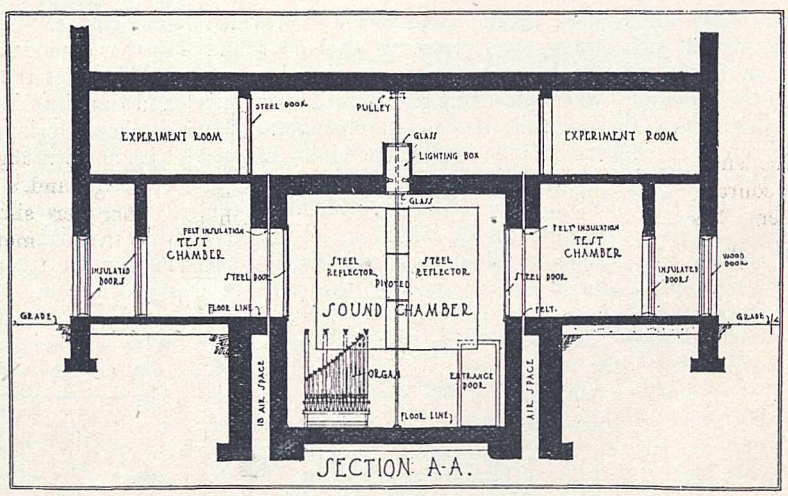

FIG. 3.—Section of Acoustic Research Building.

at least 3 ft. by 5 ft. An adjustable organ pipe blown at constant pressure formed the source of sound placed at the focus of a 5 ft. parabolic reflector facing the partition to be tested in the manner shown in

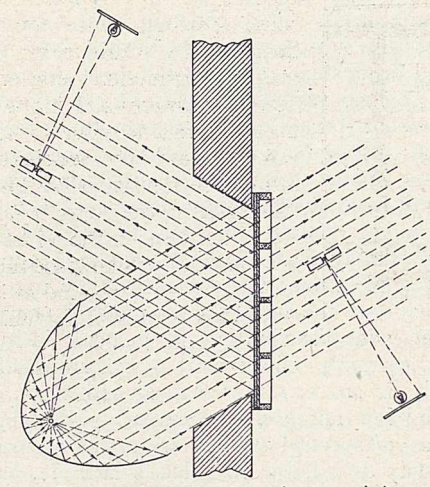

FIG. 4.—Diagram of apparatus for testing transmission and reflection of sound.

Fig. 4, and a disc resonator was placed on either side of the partition to measure the transmitted and reflected sound. Fig. 5 shows a photograph of the apparatus in use, and the observer's box provided to prevent disturbance due to his presence. The general results of the tests confirm the views of earlier experimenters cited. Porosity results in absorption but a good deal of transmission, while rigidity results in large reflection; the reflection from hair felt, for example, being 6, while that from Sackett board of the same thickness is 42·7.

The effect of openings such as doors were also tested, and it was found that if the transmission through a 2-inch metal lath and plaster partition has an intensity represented by 0·93, a 2-inch well-fitted solid wood door with three-sixteenths of an inch clearance from the floor increased this to 7·3 and with half an inch clearance to 11·7, showing the importance of even very small apertures. As regards composite partitions, the author's conclusions are that the small gain in internal reflection at surfaces of different density is usually more than counterbalanced by the loss in total rigidity, and thus in reflecting power of the initial surface of contact. In practice, of course, too much reflection may be detrimental to the uses of the room in which the sound is generated, and as is pointed out, absorption must be the ultimate aim for the destruction of sound, which means its conversion into heat.

Sound-proofing is of special interest in the modern type of business building, where, in order to economise space and admit of adaptability for changes of tenancy, the constructural brick wall has been so largely replaced by the thin partition, and experiments of the type described should be of great value to architects who are responsible for specifying materials and construction. The present writer's experience is that a wall composed of Fletton bricks, which are very dense, is less effective in stopping sound than one composed of stock bricks, which are more porous and less regular.

It would be unwise to generalise too much from the experiments described; with floors, for example, the direct contact produces conditions different from those of a sound wave in air, and through a solid concrete floor every footfall may well be heard in the room below. Much further work on this subject is needed, and it is to be hoped that investigation in this country will supplement and extend what is being done elsewhere.

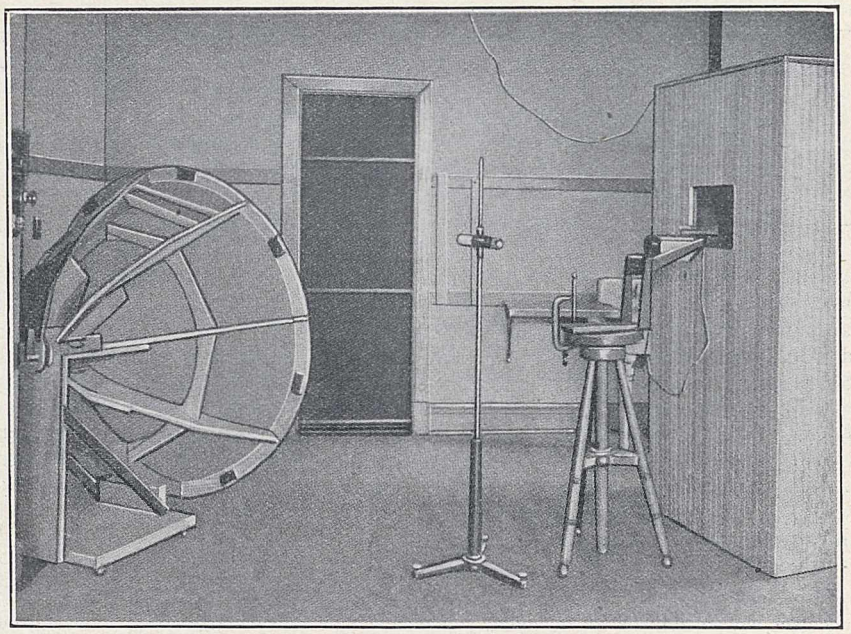

FIG. 5.—General view of apparatus.

The Galactic System.[1]

By Dr. HARLOW SHAPLEY.

II.

IN the first part of this article the main characteristics of the globular and open clusters were discussed, and it was shown how the determination of their distances led to the proposal of extremely great dimensions for the galactic system. A theory of the origin and structure of the Galaxy also seems to be indicated by the observations.

OBJECTIONS TO PROPOSED SCALE OF THE GALAXY.

Although the new values of galactic dimensions have been widely accepted by astronomers, at least qualitatively, they have been openly challenged by some. Without questioning my values (which may indeed have been unknown to him), Prof. Charlier published a few years ago provisional cluster distances that are of a wholly different order of magnitude from those I derive.[8] He had, in effect, affiliated the globular clusters with the local system of B stars. I believe he has now accepted the larger values of the distances.[9]

An extensive critical examination of my methods and results has been made by Prof. Curtis. His discussion and my reply have been published together in Bulletin No. 11 of the National Research Council.

Dr. Schouten has attempted to derive the distances of clusters by assuming that the frequency of absolute magnitude (the luminosity-curve) is the same in globular clusters and in the neighbourhood of the sun.[10] The method is questionable for several reasons: (1) All spectral types are lumped together by Schouten regardless of our present knowledge of the peculiar relation of type and luminosity in the globular clusters. (2) The giant-dwarf phenomenon is essentially ignored in the method. (3) The observed luminosity-curves in globular clusters do not conform with the law assumed.[11] (4) It is certainly improbable that the stage of evolution in any given cluster is closely comparable with the average of the many stages represented by the heterogeneous mixture around the sun. (5) As applied, the luminosity-curve method involves dangerous extrapolation, for we know the frequency of magnitudes for only the very brightest stars in clusters.[12]

Using the necessarily fragmentary luminosity-curves for a few clusters, Schouten finds distances averaging about one-eighth the values I have computed.

Recently, Kapteyn and van Rhijn published a valuable paper on the proper motions of Cepheid variable stars of the short-period sub-type.[13] It is generally accepted that Cepheid variables of long period are giant stars; and from the simultaneous occurrence of the long-period and short-period Cepheids in globular clusters,[14] I have assumed of course that the short-period Cepheids, which occur most frequently in clusters and serve in one of the methods of estimating the distances, are also giant stars. Kapteyn and van Rhijn, on the other hand, have computed, from the large values of the proper motion, small distances for the cluster-type variables, and therefore low luminosities. They conclude that Cepheid variables of this sub-type may be dwarfs, both near the sun and in clusters; and, by assuming that the long-period Cepheid variables in clusters are abnormalities and the short-period Cepheids are normal, they assert that the clusters may be at less than one-seventh the distances I place them. But Kapteyn and van Rhijn appear to have overlooked the decisive factor that the known radial velocities of these short-period Cepheids are remarkably high[15] (much too high, apparently, for the application of the method they use;[16] and therefore that the large proper motions they deduce and the wide distribution in galactic latitude are almost certainly the result of exceptionally high velocities in space, rather than an indication of nearness and low luminosity. Similarly, the long-period variables of spectral type M are giants at maximum, are widely distributed in galactic latitude, and have high space velocities.

As Dr. Crommelin has hinted recently in the *Observatory*,[17] a sufficient answer to those who would reduce the distance of clusters to one-fifth or one-tenth the values proposed, is that apparently they do not consider fully the dire consequences of such reduction on a vast body of other astronomical data that is now generally accepted. If the distances I give are not greatly reduced or increased these troubles do not arise; all that we know of the colours, spectra, magnitudes, and motions in the clusters, and of the clusters, then fits in well with our general stock of astronomical fact and theory.

Before we knew much about the character of stars in clusters we were not restricted by observation or theory from placing the clusters at whatever distances we liked. But now, if we alter the present distances by the amount Curtis, Schouten, and Kapteyn and van Rhijn suggest, we immediately set up peculiarities and discordances in great numbers. For example, among other difficulties evoked by such changes, we would seriously question the general applicability of the spectroscopic method of determining luminosities and distances;[18] we would introduce confusion into Russell's and Eddington's theories which now so happily conform with physical laws and observational results, in clusters as well as outside; we would overthrow the period-luminosity law of Cepheid variation. Sooner or later it may be necessary to divide or multiply by 1·5 (Dr. Crommelin suggests 2) the distances I have computed for the clusters; any larger factor will entail alterations elsewhere that now appear improbably large.

It seems to me that a better line of attack on the proposed scale of the Galaxy would be to question the apparent magnitudes rather than the absolute luminosities. The latter, as we have seen, are supported by too much evidence of a varied nature to yield easily. Moreover the values of the absolute luminosities for the stars in clusters come within the range of our usual experience, whereas the apparent magnitudes (and distances) of cluster stars are quite different from those of stars we ordinarily treat.

[1] Continued from p. 547.

Since the computed distances depend equally on absolute and apparent magnitudes, they could be considerably changed, if the apparent magnitudes are widely wrong, without disturbing present ideas about stellar luminosity. The fundamental work on magnitude standards at Mount Wilson, Harvard, Greenwich, and elsewhere supply, however, a basis of unquestioned value for the cluster work. The apparent magnitudes I have observed in clusters cannot, I believe, be far wrong;[19] but has the light of these distant stars been reduced in transit so that the apparent magnitudes as observed are not a true index of distance? This question should be kept in mind, but the following points seem to show that the observed apparent magnitudes do not differ seriously from true apparent values because of a hypothecated diminution of light during its passage through space:

(1) The absence of measurable differential light scattering in space, which would appear as a dependence of star-colour on distance.

(2) The apparent restriction of known obstructing matter to regions near the planes of the local cloud and the Galaxy;[20] the globular clusters we study are practically all outside these regions.

(3) The diameter-magnitude correlation for globular clusters, which shows, almost without exception, that the globular clusters with large angular diameters are bright, and that the faint globular clusters are of small angular diameter.[21]

(4) The absence of observable proper motion for clusters, notwithstanding large space velocities.

INCIDENTAL RESULTS

In the course of the investigation on the scale of the galactic system a number of incidental contributions of general scientific interest have been made.

I. The great distances of globular clusters provide a much more sensitive test of the degree of selective scattering of light in space than was formerly available from the studies of the colour of nearby stars. Results from many clusters, including the most remote, agree in showing no certainly measurable effect of distance on colour. We conclude that much less than one per cent. of the starlight is scattered while travelling for one thousand years through space.[22] This result, which does not hold of course for some restricted nebulous regions, indicates the extreme vacuity of interstellar space.

II. This absence of a measurable effect of distance on colour contributes an additional fact of some interest with regard to the nature of light. It is direct observational evidence that the amplitude of the light pulses of different wave lengths has suffered no differential alteration while travelling for more than 100,000 years. The age of this incoming stellar radiation, compared with that of the radiation used in laboratory experiments, is uncommonly impressive.

III. In a more definitely quantitative manner we can again use the base line in space and in time afforded by the globular clusters to derive another property of radiation. The times of maxima of several short-period Cepheid variable stars in the globular cluster Messier 5 (distance 12,000 parsecs) have been measured concurrently with blue and yellow light. Within the errors of observation no difference for the two colours is found in the time of these stellar outbursts.[23] That is, in travelling for 40,000 years, radiation that differs in wave length by 20 per cent. differs in time of arrival at the earth by less than two minutes, if at all. This is equivalent to a difference of less than one millimetre in a distance of 5000 miles. Stated otherwise, blue and yellow light travel with the same velocity with an uncertainty of less than one part in ten thousand million.

IV. In still another way can we make valuable use of the long base line provided by the remote clusters. A considerable analysis of the distribution of spectral types among the giant stars shows no measurable difference for near and distant globular clusters. This strongly suggests of course that the nearest systems are not appreciably more advanced in their evolution; but because of the finite velocity of light and the great differences in distance, they are, in our records, nearly 200,000 years older than the farthest ones. With these globular clusters we can, in effect, examine the process of stellar evolution throughout an interval of 2000 centuries. We find no evidence of change in that interval of time.[24]

Now Eddington has shown that very conspicuous advances in the evolution of a giant star would occur in less than 50,000 years, if gravitation is the main source of radiant energy.[25] We are led to believe, therefore, that gravitational contraction is not the main source of the energy that maintains the radiation of stars; it appears that the energy must come from the atom, and probably is released in the course of the transformation of the chemical elements.

The evidence for a slow stellar evolution is strongly supported, I believe, by the existence of stars, which are still in their giant stage, in the open clusters that move along the galactic plane. Dimensions now assigned the galactic system are so large that a single oscillation of a cluster must require millions of years. In fact, a greater space scale for the Galaxy practically makes necessary a long time scale and a slow stellar development. The extreme slowness with which the periods of Cepheid variables change, as Eddington has pointed out, also demands the new source of energy.[26]

V. In this connexion it may be observed that the question of the dependence of the speed of evolution on mass for a giant star is probably answered observationally by the regularly occurring phenomenon in clusters of increasing blueness with decreasing brightness. The well-known investigations by Eddington and Jeans indicate that high absolute brightness is associated with great mass, but the theory is not definite in regard to the relative rates of evolution for different masses. From the clusters we would conclude that the greater the mass the slower the development.[27]

VI. The most luminous stars in globular clusters, the spectra of which, by the way, appear to have the "*c*-characteristics" which are associated with extraordinary brightness, are more concentrated to the centre than fainter stars. This condition independently supports the inference that the most luminous are the most massive stars.

VII. The remotest object for which a definite estimate of distance has yet been made is one of these

faint globular clusters, N.G.C. 7006, for which a value of about 65,000 parsecs (more than 200,000 light-years) has been obtained, and checked by three or four different photometric methods. The most recent determination of its distance involved the discovery and study with the 100-inch reflector at Mount Wilson of Cepheid variables of the 19th apparent magnitude—the faintest periodic variable stars on record. It is likely that more remote objects, with distances as yet unmeasured, have been seen or photographed—possibly among the faintest spiral nebulæ or among the faint stars in the Milky Way.

VIII. A recent investigation of Cepheid variable stars in the Small Magellanic Cloud has shown that the very faintest variables have periods of less than one day.[28] This result, which permits the direct extension of the period-luminosity law to the short-period type of Cepheid, is further evidence of the high absolute luminosity of the kind of Cepheid variable which is most frequent in globular clusters.

IX. The proposal of a larger scale for the galactic system brings us face to face with the "island universe" theory of spiral nebulæ, which, with varying success, has for many years maintained that the spirals are other "universes" of stars—that they are galaxies comparable with our own, and that our Galaxy, seen from a sufficient distance, would appear as a spiral nebula. A theory of "comparable galaxies" immediately becomes very difficult to maintain along with the larger dimensions of the galactic system. In a paper published three years ago I discussed at some length this problem of external galaxies.[29] The conclusion reached at that time, that the nebulæ of the spiral family are probably neither galactic in size nor stellar in composition, has been strengthened rather than weakened by subsequent investigations, particularly by van Maanen's remarkable work on the motions in the brighter spirals.[30]

X. Since the brighter spiral nebulæ, according to the present view, are probably within the boundaries of our galactic system, it may be that the novæ occurring so frequently in the Andromeda nebula represent the encounter of this enormous, rapidly moving object with galactic stars. The suggestion is in harmony with the Seeliger-Monck hypothesis of the cause of ordinary nov; andæ, moreover, it is in line with the only hypothesis that has yet been advanced to account for the peculiar irregular variable stars in the diffuse nebulæ, such as those in Orion.[31] This interpretation of the variables of the relatively near Orion nebula would certainly be of significance for historical geology, since disturbances of our sun, much less serious in character than those observed for novæ and for the Orion variables, would be of paramount importance in matters pertaining to terrestrial climates and organisms.[32]

XI. Conversely we can use the geological records to show that the radiating equilibrium of the sun probably has been uncommonly stable compared with that of many stars. The investigation at Harvard under Prof. Bailey's direction of the frequency of galactic novæ brought out the remarkable result that at least fifteen novæ, brighter than the tenth magnitude at maximum, have appeared every year during the last three decades.[33] If a frequency of even one-fifth that amount has been maintained throughout the hundreds of millions of years of approximately constant solar radiation (shown by the geological records), more novæ have occurred than there are known stars. Our sun, however, which has certainly escaped not only disasters of this kind but even much less serious disturbances, apparently moves in an uneventful region of space.

XII. The attractive and somewhat futile speculations on the probability of the occurrence of protoplasmic life and its slow evolution elsewhere in the sidereal system must, of course, take account of the frequency of these calamitous stellar outbursts that we call novæ.

In connexion with this attempt at a partial interpretation of galactic structure it might be well to emphasise the following points.

(1) Many of the fundamental laws and assumptions of physics are involved in this sidereal superstructure, so that developments in thought or observation, which hereafter greatly affect these laws and customary assumptions, may at the same time seriously disturb existing conceptions of the sidereal system.

(2) The complete elucidation of the source of stellar energy may bring with it modifications both in our views of the evolution of stars and in our assumption of the importance of gravitational organisation of stellar bodies.

(3) The question of the obstruction of light in space is not in a satisfactory condition, and the nature of the radiation of the diffuse nebulæ is little understood; we have essentially no information concerning the pre-giant stage of stars and its relation to the diffuse nebulæ, and the dust and gases in space.

(4) Cepheid variables, though comparable with each other, may possibly be sufficiently different from other stars that we cannot use their speed of evolution as a quantitative measure of the speed of evolution for all stars.

For the present I take little heed of these warnings, and merely record them as examples of underlying uncertainties. They serve to remind us that the conclusions are based not only on favourable observations and theory, but also on the absence (for the time being) of seriously unfavourable data.

REFERENCES.

8. *Lund Meddelanden*, Series 2, No. 19.
9. Bul. Nat. Research Council, No. 11, p. 174.
10. Proc. Acad. Sci. Amsterdam, 20, p. 1108; 21, p. 36.
11. *Mt. W. Contr.* 155, and 175, p. 11.
12. I first tried out the method six years ago (*Mt. W. Contr.* 116, p. 81), but abandoned it as wholly unsuited to the brighter stars in globular clusters. The Kapteyn luminosity curves for separate spectral types, however, may be of high value.
13. Bul. Ast. Inst. Neth., No. 8.
14. Kapteyn and van Rhijn state that eight Cepheids of long period are known in two globular clusters. In my paper from which they get their data (*Mt. W. Contr.* 151) I show that twelve long-period Cepheids occur in the five globular clusters Messier 3, 5, 13, 15, and Omega Centauri. Four of these clusters contain also large numbers of short-period Cepheids only one or two magnitudes fainter than the long-period Cepheids. Unpublished results obtained at Harvard show that long-period Cepheids occur in other globular clusters.
15. *Mt. W. Contr.* 153, *Mt. W. An. Rep.* for 1918, and elsewhere.
16. Russell, *Astroph. Jour.* 54, p. 140.
17. *Observatory*, May 1922.
18. Bul. Nat. Research Council, No. 11, p. 184, 190.
19. The photovisual magnitudes for Messier 11, however, are probably affected by a serious scale error; the colour indices do not agree with the spectra subsequently determined (*Mt. W. Contr.* 120 and 228).
20. *Mt. W. Commun.* 62, p. 6; cf. also Hubble, *Mt. W. An. Rep.* for 1921, p. 251.
21. *Mt. W. Contr.* 115, p. 12, 152, p. 10, and 161, p. 13.
22. *Mt. W. Contr.* 156, p. 5.

23. *Harv. Bul.* 763.
24. *Mt. W. Contr.* 156, p. 5, and 157, p. 14.
25. *Zeits. für Physik*, 7, p. 390.
26. Mon. Not. R.A.S. 79, p. 19.
27. This conclusion may not hold for close double stars, as certain results from eclipsing binaries are not in full agreement; the less dense, dark companion is believed to be, frequently, less massive and also less developed than its primary.
28. *Harv. Bul.* 765; Proc. Nat. Acad. Sci. 8, p. 69.
29. Pub. Ast. Soc. Pac., October 1919.
30. *Mt. W. Contr.* 213 and 214.
31. *Mt. W. Contr.* 156, p. 12; cf. Graff, *Ast. Nach.* 5133.
32. *Jour. of Geol.* 29, p. 502.
33. The annual number brighter than the tenth magnitude actually exceeds forty, according to Bailey's data. Pub. Am. Ast. Soc. 4, p. 248.

Current Topics and Events.

IN an article on Lord Inchcape's task in the *Sunday Times* of October 22, a former finance member of the Government of India, Lord Meston, makes an alarming suggestion. Speaking of things "useful, but not essential," he says "many of the research institutes and the like will come under the shears." The illiberal spirit which inspired our domestic wielders of the axe may thus be carried by one of them to India—a country which, more than any other, perhaps, has benefited by the application of science to "useful" purposes. The plant breeders there, alone, have literally added millions to the country's wealth; new wheats and cottons yielding 20 to 30 per cent more than the indigenous varieties have already been successfully introduced. It must not be forgotten that, in India, the prosperity of agriculture is a fundamental element of the solvency of the Government, for there, the State, as owner of the soil, takes one half of the rental value of the land. The sum thus raised approaches a moiety of the whole taxation of the country. It is to be hoped that such a suicidal policy as that indicated by Lord Meston will not be advocated by Lord Inchcape, though as a quondam member of the Geddes Committee he may be inclined to repeat its mistakes.

THE French airman, M. Maneyrolle, won the prize of 1000*l.* offered by the *Daily Mail*, by a wind flight on October 21 lasting three hours and twenty-two minutes. The notable successes registered during the recent French contests, and especially during the German contests, raised the question whether British fliers could rival the feats of their foreign colleagues, and the offer of a prize of 1000*l.* by the *Daily Mail* led to the organisation, at Itford Hill and Firle Beacon on the South Downs, of the first British gliding contests since the war, which commenced on October 16 and continued through the week. Additional prizes were offered by the Royal Aero Club and others. The entry of British machines and pilots was very encouraging, there being some two score British fliers, besides foreign aviators, notably the Dutch airman, M. Fokker. A large number of short flights and some quite long flights were made; yet on the whole the results of the meeting were not of a sensational nature until the last day of the meeting. The general conclusion is that British aviators do not fall behind those of Germany, and that it is possible to find suitable arenas in this country for the practice and display of motorless flight. The most notable achievement of the first day of the contest was a thirty-seven-minute glide by M. Fokker, but this was surpassed by a fine flight executed by Mr. F. P. Raynham. This aviator had already taken a place in the front rank of British pilots in the recent air-race round England: he added to his laurels by remaining in the air in a motorless machine for one hour and fifty-three minutes, thus putting himself in the same category as the German record-makers, Martens and Hentzen. But on the last day, Saturday, two world-records were nevertheless established. J. R. Olley went up in a Fokker biplane, and remained in the air with a passenger for forty-nine minutes, while M. Maneyrolle, in a tandem monoplane glider, succeeded in remaining in the air for three hours twenty-two minutes, thus winning the *Daily Mail* prize and beating the previous record, that of Hentzen, by twelve minutes. During the last ninety minutes of his flight, M. Maneyrolle was accompanied by a monoplane glider flown by Squadron-Leader A. Gray, and it was night when the two machines landed within 100 yards of the point from which they started. These competitions on the South Downs will serve as an encouragement to motorless flight in this country, and will help in the accumulation of knowledge and experience on one of the most interesting developments in modern aeronautics.

THE height of the ground at Firle Beacon, where the gliding competition referred to in the foregoing paragraph was held, is 718 feet above sea level, and it slopes downwards somewhat to Itford Hill, which is situated about three miles to the westward. The gliding was chiefly from one or other of these positions. The meteorological conditions during the week could not be considered altogether favourable, and there was wide difference in the weather on the several days. At times the winds were too boisterous and unsteady for gliding, while at others the gliding was hampered by winds which were too light or by cloud and mist; the direction of the wind was chiefly from between north and east. On the closing day, Saturday, the surface wind was blowing at the rate of about 20 to 30 miles an hour, and M. Maneyrolle, in his record flight, kept mostly at about 200 feet above ground. The controlling conditions of the weather were similar throughout the week; a region of high barometer was situated to the north of Scotland and a region of low barometer was fairly stationary over the north of Spain. All who took part in the gliding contest, however, would know well what different weather could be experienced with similar controlling conditions.

AT a meeting of manufacturers held on October 18 at the Institution of Electrical Engineers it was unanimously agreed, in view of the approval of the Postmaster-General to the memorandum and articles of association of the British Broadcasting Company having been obtained, to proceed with the registration of the company. The capital of the company,

amounting to 100,000*l.* in 1*l.* shares, has been guaranteed by the British Thomson-Houston Company, General Electric Company, Marconi's Wireless Telegraphy Company, Metropolitan-Vickers Electrical Company, Radio Communication Company, and the Western Electric Company: *bona-fide* British manufacturers alone will be allowed to join the broadcasting company and may take up one or more shares. The guaranteeing companies are immediately responsible for 60,000*l.* of the capital, and the balance of 40,000*l.* is offered for subscription: should applications be received for a number of shares in excess of the balance mentioned, the guaranteeing companies will reduce their holdings with the view of meeting the applications of other manufacturers. Lord Gainford has consented to become the chairman of the board of the broadcasting company, which, in the words of its memorandum, is a public utility service for the broadcasting of news, information, concerts, lectures, educational matter, speeches, weather reports, and theatrical entertainments. Each member of the broadcasting company is required to make a deposit of 5*o*l., returnable to him when he withdraws therefrom; he must also enter into an undertaking neither to sell any apparatus, except batteries, accumulators, and aerial equipment, not made in this country, nor to make broadcasting apparatus for any person who is not a member of the company. For transmission purposes, every member owning an invention must give the use of the same to the company, *i.e.* all patents are to be pooled, so that the broadcasting company will be free of royalties. The expenses of broadcasting are to be met partly from the fees collected on broadcasting licences, the Postmaster-General having agreed to pay over one half of the 10*s.* to be charged for each licence to the company, and partly by contributions, on a royalty basis, to be made by the members of the broadcasting company; the scale of these contributions ranges from 2*l.* 5*s.* in respect of each three-valve set to 2*d.* in respect of each single valve sold. The date for opening broadcasting services has not yet been definitely fixed.

AT a joint meeting of the Royal Geographical Society and the Alpine Club on October 16, General the Hon. G. C. Bruce, Mr. G. L. Mallory, and Mr. G. I. Finch gave accounts of the recent expedition which failed by 1700 ft. to reach the summit of Mount Everest. Mr. Mallory said that in light of the experience gained this year the problem of climbing the mountain must be reviewed afresh. The most important modification must be in respect of porters. On this expedition porters had carried a camp to 25,500 ft. and had shown astonishingly little fatigue. It seemed certain that after a night's rest at 25,000 ft. the porters could carry a camp to 27,000 ft. If this could be done, it would facilitate the task, which would then depend on the endurance of the trained climbers. This would entail a climb of 2000 ft. and the corresponding descent in a day. The effort of climbing the last 2000 ft. should not be considerably greater than that of climbing from 25,000 ft. to 27,000 ft., for the difference in atmospheric pressure is only 0·8 in. between 27,000 ft. and the summit, compared with a difference of 19·5 in. between sea-level and 27,000 ft. But the fatigue of the previous days' efforts and possibly the ill-effects of sleeping at high altitudes would tell against the climber on the last lap. Mr. Mallory is not inclined to think that with the help of oxygen the feat was impossible. A significant fact was that three climbers at a height of 27,000 ft. felt no special distress. Two other considerations must be borne in mind: the dangers involved in avalanches and in the possible loss of muscular power, and the difficulties due to weather. The latter was most serious. Unless the bad weather of this year was abnormal, the weather factor reduces the likelihood of men reaching the summit of Mount Everest and descending in safety.

IT was stated in NATURE for September 16, p. 394, that a committee had been appointed to work out a proposed Federation of American Biological Societies. The constitution proposed by that committee is published in *Science* for September 29. It follows the main lines adumbrated in our previous note. We are glad to observe that, in the opinion of the committee, the Federation should in no way conflict with existing organisations, but should rather strengthen their efforts and should avoid unnecessary duplication of effort and expenditure. It proposes therefore to act in close co-operation with such existing agencies as the American Association for the Advancement of Science and the National Research Council. The kind of work that may be undertaken by such a Federation appears from the fact that the proposed constitution calls for the appointment of a Committee on Bibliography and Publication to act in co-operation with similar committees that may be appointed by the two bodies just mentioned. It may be remembered that the British Association has a committee dealing with the zoological branches of this subject, and that the recent Conference of Corresponding Societies requested the Council of the British Association to inquire into the general question of scientific bibliography.

MR. SPURLEY HEY, Director of Education in the city of Manchester, has been moved by our article on "Children and Museums" (NATURE, September 2, 1922) to send us a report on the lectures for elementary school children in the Museums and Art Galleries of Manchester. We were well aware of the admirable work begun in Manchester as a war measure, but found so successful that it has since been continued and extended. Classes are at present held in six institutions, and it is hoped to include three others. Of the eleven demonstrators engaged, nine are certificated teachers. Every attempt is made to co-ordinate the museum work with the inside work of the schools. There seems to be a larger demand for the science courses than for those at the art galleries, but all the courses are exceedingly popular with the children. The general opinion seems to be that these classes awaken the intellect of the children. It is natural that they should help them in such subjects as geography and science, but it appears that they also improve their drawing, teach them in

a practical way the elements of civics, cultivate their manners, and even give the children an increased pleasure in poetry. Indeed there is scarcely a side of education that is not improved in this way. We are not in the least surprised, and we commend Mr. Spurley Hey's report to all educationists as well as to those museum authorities at whom our previous remarks were aimed.

COMMANDER FRANK WILD, leader of the Shackleton-Rowett Expedition after the death of Sir Ernest Shackleton, and Mr. John Quiller Rowett, who financed the expedition, had the honour of being given an audience by the King on Monday morning. The King expressed his deep regret for the untimely death of Sir Ernest Shackleton, and complimented Commander Wild on the successful work accomplished.

WE much regret to announce the death on October 27, in his eighty-second year, of Mr. W. H. Wesley, for forty-seven years assistant secretary of the Royal Astronomical Society.

THE second annual meeting of the Deutsche Gesellschaft für Vererbungswissenschaft was held in Vienna on September 25-27. Though technically a meeting of the German society only, in fact the congress was largely international in character, the visitors including representatives from England, America, Italy, Switzerland, Japan, Holland, and the Scandinavian countries. Prof. R. Wettstein presided, and the opening address was delivered by Prof. E. Baur (Berlin). The principal discussions were opened by Prof. Goldschmidt (Berlin) on "The Mutation Problem," and by Prof. Ruedin (Munich) on "The Inheritance of Mental Defects." Among the papers which were read and briefly discussed were the following: the modification of sex factors in fungi, by H. Kniep; relative sexuality, by H. Hartmann; *experimenta crucis* on the inversion of sex, by R. Goldschmidt; experiments with hermaphrodite frogs, by E. Witschi; linkage in antirrhinum, by E. Baur; the deficiency phenomenon in Drosophila, by O. L. Mohr; methods of obtaining different sex-proportions in Drosophila, by G. Bonnier; polymery in butterflies, by H. Federley; parthenogenesis, gynandromorphism, and the determination of sex in phasmids, by H. Nachtsheim; Blakeslee's experiments on heredity in Datura, by C. B. Davenport; the influence of temperature on the offspring of rats, by H. Przibram; the influence of light on butterflies, by E. Brecher; genetic studies in barley, by E. Schiemann; vegetative segregation in *Lupinus angustifolius*, by H. Roemer; transplantation and relationship, by Frl. Erdmann; the inheritance of Hæmophilia and its importance for our conception of the nature of genes, by H. K. Bauer; and variability and the formation of species, by P. Schlesinger. Demonstrations were arranged in the zoological laboratory of the University and in the Natural History Museum. Visits were made to the Biologische Versuchsanstalt (where Prof. Steinach demonstrated his transplantation experiments in rats and guinea pigs) and to the principal libraries and art galleries in the town. Prof. R. Hertwig was elected president for the ensuing year, and the society accepted his invitation to meet at Munich in 1923.

AN international exhibition of technical, artistic, and scientific photography, optics and cinematography, with a section for the history of photography, will be held in May and June of next year at Turin, Italy. Information can be obtained from the Comitato dell' Esposizione Fotografica, presso la Cemare di Commerciodi, Torino, Italy.

THE council of the Hancock Museum has appointed Mr. T. Russell Goddard, at present assistant curator at the Sunderland Museum, to the position of curator of the Hancock Museum, Newcastle-upon-Tyne. Mr. Goddard was trained under Mr. Montague Browne, and then worked on the staff of the Leicester Museum under Mr. E. E. Lowe for six years, arranging and classifying the local fauna and flora. Thence he proceeded to engage in biological research work in the laboratory of Dr. C. F. U. Meek, previous to his appointment at Sunderland about two years ago.

WE have received the second quarterly issue for this year of *Process Work and the Printer*, which contains among other interesting items an article on "The History of Printing Types," reprinted from the *Printing Supplement* to the *Manchester Guardian*. It is illustrated with many specimens from Gutenberg's first type (1455) to those of the present day. One of the three inset illustrations is a photogravure in colour, but the original water-colour drawing is of such a character that it is not possible to judge of the quality of the reproduction. The editor states that it marks a notable departure in photogravure printing in that it necessitates the printing of a large edition instead of only a few proofs as has hitherto been the case in colour photogravure.

THE Cantor Lectures delivered recently before the Royal Society of Arts by Prof. Arthur M. Hind, Slade professor of fine art in the University of Oxford, on "Processes of Engraving and Etching," are printed in the Society's Journal for September 22. The lecturer does not treat the subject as a practical engraver, but from the point of view of the historian and critic. He seeks chiefly to discriminate the characteristics and limitations of the various processes, and their peculiar fitness for certain kinds of work. The subject is richly illustrated by reference to a very large number of examples. Prof. Hind concludes by stating that "perhaps the greatest danger to recent etching has been its popularity; the public has preferred a bad etching to a good woodcut or lithograph, leaving these other arts a safer though less prosperous field. It is perhaps on that account that some of the best etchers are those who have exhibited least."

DR. GEORG BERG has written to us with reference to a review of his work on ore deposits published in NATURE of August 12, p. 205, to point out that the reviewer has done him an injustice in stating that he restricts the term syngenetic deposits to magmatic segregations. In this correction Dr. Berg is undoubtedly right; he does include among syngenetic deposits such ore beds formed by sedi-

mentation as have undergone no chemical change since their deposition, as well as clastic deposits. Unfortunately, he has dealt with the former type of syngenetic deposits (magmatic segregations) first, has then passed to the study of epigenetic deposits, and then, after some 280 pages out of a total of 400 devoted to epigenetic deposits, he reverts to the last two classes of syngenetic deposits, and this method of dealing with the subject caused the reviewer to overlook the fact that Dr. Berg had commenced by stating that these two last classes (ore beds and clastic deposits) were also syngenetic. This explanation will, we trust, suffice to remove the wrong impression created by the comment to which Dr. Berg refers.

MESSRS. W. HEFFER AND SONS, Ltd., are bringing out "Fundamentals of Bio-Chemistry in Relation to Human Physiology," by T. R. Parsons, which is intended to form an introduction to the study of the chemical processes at work in the body. It is addressed more particularly to medical students reading for examinations in physiology. Another forthcoming book in the same publishers' list is "The Ethnology of the American Indians," by Dr. P. Radin, in which particular stress is laid upon a clear delineation of the civilisations of Mexico and Peru and their influence on the culture of the other parts of America. A useful feature of the volume should be the detailed and critical bibliography it is to contain.

Our Astronomical Column.

A NEW COMET.—A new comet, 1922 *c*, was discovered by Dr. Baade at Bergedorf Observatory, Hamburg, on October 19, and observed by Prof. Strömgren at Copenhagen on October 22, $8^h\ 15{\cdot}7^m$ G.M.T., in R.A. $19^h\ 52^m\ 57{\cdot}7^s$, N. Decl. 36° 57′ 38″. He gave the magnitude as 9·0, so the comet should be visible in small telescopes. Assuming uniform motion, the following are the positions for the dates named at 8^h P.M. :

	R. A.	N. Decl.
Oct. 28.	$20^h\ 6^m\ 2^s$	35° 22′
,, 31.	20 12 35	34 33
Nov. 3.	20 19 8	33 44

The comet is in Cygnus, and is due south, 15° from the zenith, at $5^h\ 30^m$ P.M.

SPECTROSCOPIC PARALLAXES FOR TYPE A.—The spectroscopic method has hitherto been limited to spectral types F G K M. A paper by Messrs. Adams and Joy (Proc. Nat. Acad. Sci., July 1922) gives the details of an investigation as to its extension to type A. It had already been noticed that there was a difference in the general sharpness of the spectral lines in stars of this type, and on examining the stars the distance of which is known either by trigonometrical, hypothetical, or moving-cluster parallaxes, there is found to be a distinct correlation between absolute magnitude and sharpness of lines. Using the letters s, n to denote sharp and nebulous spectra, they give the following values for the absolute magnitudes of different types: A1 s 0·0 n 1·2, A2 s 0·6 n 1·5, A3 s 1·2 n 1·7, A4 s 1·5 n 1·9, A5 s 1·8 n 2·1, A6 s 2·1 n 2·2. After this point the two coalesce. They apply the formulæ to the Taurus group and the Praesepe, finding parallaxes of 0″·024 and 0″·011 respectively. Certain stars had already been classified at Harvard as C-stars. They have very sharp and narrow lines, and the enhanced lines, especially those of strontium at 4077 and 4215, are very intense. There is reason to think that these stars, of which α Cygni is the most prominent example, are super-giants, to which the preceding formulæ do not apply. They are very luminous and very remote, but material for assigning parallaxes is at present wanting. The authors note that in all spectral types sharpness of lines is associated with high luminosity. They explain this by the very low density of the giant stars.

A paper by Mr. Evershed in the Mon. Not. R.A.S. for last May noted that there were many broad hazy lines in the spectrum of Sirius; he pointed out that in Sir Norman Lockyer's classification, Sirius is on the descending side of the temperature curve, and quotes his words that in stars of this class the hydrogen lines are relatively broad. Mr. Evershed is inclined to explain the widening as a Doppler effect due either to rapid rotation or strong convection currents. But, whatever the cause, the facts are in accord with the results of Adams and Joy.

GLOBULAR CLUSTERS IN THE LARGE MAGELLANIC CLOUD.—In Harv. Coll. Observ. Bulletin, No. 775, is announced the discovery that five objects formerly catalogued as nebulæ are definitely globular clusters. Their N.G.C. numbers are 1783, 1806, 1831, 1846, 1978. The status of two others, Nos. 1651, 1866, is doubtful. The detection of new globular clusters is interesting, since it was announced a few years ago that probably all objects of this class within our reach had been detected. It also enables a new estimate to be made of the distance of the cloud, using Prof. Shapley's formulæ. At present only the simple formula based on apparent diameter has been applied. The diameters of the above five objects are 1′·9, 1′·6, 1′·9, 1′·8, 1′·8. The corresponding distance is 35 kiloparsecs, or 110,000 light-years. This is of the same order as Hertzsprung's estimate. It makes the linear diameter of the large cloud $4\frac{1}{2}$ kiloparsecs, so that it is comparable in size with our own star system, leaving the outlying galactic extensions out of account.

VARIABILITY IN THE LIGHT OF IRIS.—Prof. Wendell noted in 1904 that this minor planet was variable in light to the extent of 0·35 mags. in 0·259 days. Mr. Campbell found the same period but a smaller range in 1917. But Miss Harwood at the Maria Mitchell Observatory finds no variation in the present year. The case is like that of Eros, and may arise from irregular shape of the object, the amount of variation depending on the direction of the line of sight; it has been suggested that a further complication might arise from a shift in the axis of rotation in the body of the planet, if it were rotating about an axis other than a principal one. The shape of the asteroids might give a clue in questions of cosmogony, hence such researches are useful. In the case of Eros, when observed for parallax there is the possibility of error if the centres of light and of gravity are non-coincident. Mr. Hinks, indeed, found some evidence of a small oscillation of this kind, but the effect would probably disappear in the mean of many observations.

Research Items.

Earthworks in America.—The Peabody Museum of American Archæology and Ethnology, Harvard University (vol. viii. No. 3), has issued a monograph by Mr. C. C. Willoughby on the Turner group of earthworks in Hamilton County, Ohio, with notes on the skeletal remains by Mr. E. A. Hooton. The book, admirably illustrated by sketches and photographs, gives a full account of these interesting structures. Mr. Willoughby remarks that the builders attained a degree of excellence in art design probably unsurpassed north of Mexico. It is important to note that they show no affinity with the people of the Madisonville site, beyond those which are common to all Indians. Their affinities are rather with the Eastern dolichocephals, although there is present a brachycephalic element such as is often found among the Eastern Indians.

Long Barrows in the Cotswolds and Welsh Marches.—Under the title of "Notes on the Archæological Information incorporated in the Ordnance Survey Maps," Mr. O. G. S. Crawford, Archæology Officer, Ordnance Survey, has published a useful pamphlet with a map showing the position of the Long Barrows and Stone Circles in the Cotswolds and the Welsh Marches. He remarks that the fact that the Cotswold limestone area is a region of relatively high elevation has led some to suppose that this accounts for the abundance of long barrows in this district. But the factors which influenced prehistoric man in the choice of a settlement were not elevation but vegetation and water supply. Prehistoric man selected these limestone areas when the soil favoured an open growth of vegetation, because many regions of high elevation, such as the Black Mountains, are entirely devoid of long barrows. He chose sites where the streams are more numerous, and in Monmouthshire the position of two out of the three long barrows shows that Neolithic man did not shun the lowlands when they served his purpose. Mr. Crawford's introductory essay is interesting and suggestive, and it may be hoped that archæologists will soon be in possession of similar maps indicating the position of prehistoric remains in other districts.

The Painted Glass of Gloucester Cathedral.—In that gem of ecclesiastical architecture, the Lady Chapel of the Abbey, Gloucester, the east window, a work dating from the end of the 15th century, at once attracts attention. But the glass is in such a confused and disordered state that the ordinary spectator is scarce able to distinguish any definite subject, and carries away the impression of a mere mass of richly toned fragments, with here and there a face or a form dimly visible. The scheme of the window was obviously to illustrate miraculous stories about the Virgin, but hitherto little has been done to arrange the fragments in a definite way. In the Transactions of the Bristol and Gloucestershire Archæological Society for 1921 (vol. xliii.) Mr. G. M'N. Rushforth, working on a catalogue prepared in 1915 by Mr. J. D. Le Couteur, a well-known authority on medieval glass, publishes an exhaustive paper, supplied with good photographs. Many of the figures and incidents have now been satisfactorily identified, and much new light is thrown on an important collection of 15th century painted glass.

Germination of Indian Barley.—Experiments on the influence of atmospheric conditions on the germination of Indian barley have been carried out by Mr. W. Youngman, Government economic botanist, United Provinces, and the results, which have been published as a memoir of the Indian Department of Agriculture, are summarised in the *Bulletin of the Imperial Institute* (vol. 20, No. 2). It was found that if barley is exposed to an atmosphere containing a large amount of moisture, its germinating capacity is seriously reduced and may even be destroyed entirely. Such a condition of the atmosphere exists in North-eastern India during the period of the monsoon, *i.e.* after May, and consequently the germinating power of barley shipped from Calcutta after May is liable to be low. Barley produced in North-western and Central India would not meet with adverse conditions at any time, and although the humidity of the atmosphere along the sea-board area from Karachi to Bombay is high after May, barley exported at that period from these ports would not suffer appreciably if it were not delayed long in the sea-board area. In 1912–13 nearly 300,000 tons of barley, of a total value of about 1¾ million pounds sterling, were shipped from the various ports; about two-thirds from Karachi, slightly less than one-third from Calcutta, and a small quantity from Bombay. No barley has been exported to this country from India during the last three or four years, but when shipments are again made, the results of this work should be borne in mind.

Palæobotany and Earth-history.—The importance of the correct determination of fossil plants from the point of view of stratigraphers is well brought out in two short papers by Prof. A. C. Seward in the Quarterly Journal of the Geological Society of London, vol. 78, part 3, Sept. 1922. In one, the first fossil plants recorded from Ceylon are described, from specimens collected in dense jungle by Mr. E. J. Wayland. They prove the existence of Middle Jurassic strata, comparable with those of Madras. The second paper deals with Carboniferous plants collected by Mr. J. A. Douglas on the west coast of Peru. Dr. F. Fuchs recorded plants from this locality as Carboniferous in 1900, but he included two Wealden species, which Prof. Seward is inclined to reject in the absence of further evidence. If the list now given could be regarded as representing a flora of Upper Carboniferous age, its north-European affinities and the absence of any member of the Glossopteris flora would give it special significance. Prof. Seward, however, states that it may be Lower Carboniferous. Mr. J. A. Douglas, in the discussion on the paper, suggested that a chain comparable in height with that of the existing Andes may have formed an effectual snow-clad barrier between the region supporting the Gondwanaland flora and that yielding a more normal Carboniferous type farther to the west.

American Vertebrate Palæontology.—A number of short "Contributions from the Paleontological Laboratory" of the Peabody Museum, Yale University, have of late been appearing in the *American Journal of Science* (vols. ii. to iv.). E. L. Troxell, from "A Study of Diceratherium and the Diceratheres," is led to divide the true Diceratherium, Marsh, of the Great Basin of Oregon, from those of the Great Plains of Nebraska and Wyoming, which he refers to a new genus Menoceras, and further to separate both from Aceratherium, Kaup. The same author, treating of "Oligocene Rodents of the genus Ischyromys," hazards the suggestion that this genus developed into the modern prairie-dog, Cynomys. Mr. Troxell has also investigated "the genus Hyrachyus," which he considers divisible into three groups. R. S. Lull supplies a "Restoration of *Blastomeryx marshi*" and discourses on the "Primitive Pecora in the Yale Museum," among which with other novelties is described *Nanotragulus loomisi*, gen.

et sp. nov., from the Miocene of Wyoming. M. R. Thorpe describes a "New genus of Oligocene Hyænodontidæ," from South Dakota, under the name of Neohyænodon. He also discusses the "Oregon Tertiary Canidæ" and "A new Merycoidon" as well as "Aræocyon, a probable old world migrant." The last-named, founded on a jaw from the Middle Pliocene of Oregon, has its nearest ally in *Simocyon primigenius*, Roth, from the Pikermi beds near Athens, and should it prove to be a derivative of purely American ancestry it will, the author considers, be one of the most remarkable cases of convergence known to the science of vertebrate palæontology. Finally, in a more lengthy paper Mr. Thorpe describes "Some Tertiary Carnivora in the Marsh Collection," including new forms.

RAIN-PRODUCING INFLUENCES IN SOUTH AUSTRALIA.—From an examination of the rainfall records and other evidence in South Australia, Mr. E. T. Quayle has come to the conclusion that there is an area of marked rainfall improvement lying south-east from Lake Torrens, where in places it ranges as high as 20 per cent. In the Proceedings of the Royal Society of Victoria, 34 (N.S.), Pt. II., Mr. Quayle discusses the reasons of this improvement and its bearing on the reclamation of arid areas in the interior. The area of improvement in South Australia is continuous with a similar one in Victoria, and both are in contrast to areas of marked decrease to the north. Irrigation as a source of improved rainfall cannot operate in South Australia, for it has made practically no progress. Mr. Quayle finds the causes in changes in vegetation, due to settlement, and to variations in the water supply of the great inland lakes. From various data it would appear that Lake Torrens and Lake Frome are now impounding more water than formerly, but quantitative data are difficult to obtain. Certain places to the south-east or lee of the lake show increased rainfall in recent years, while places beyond its influence show a decrease. The full cause of the increase of water in these lakes is not clear, but Mr Quayle considers that the substitution of cereal crops or grass for Mallee scrub leads to a marked increase in rainfall. The destruction of forest trees and the extension of pastoral lands are aids in local rain production. This matter is of so much importance that it is to be hoped that investigations on a larger scale will be undertaken.

THE LIGNITE OF THE LOUGH NEAGH CLAYS.—Evidence is accumulating to show that the Lough Neagh Clays in the counties of Tyrone and Antrim are of Oligocene rather than Pliocene age. The recent deep boring at Washing Bay has yielded to Prof. Johnson and Miss J. G. Gilmore (Sci. Proc. R. Dublin Soc., vol. 17, p. 59, 1922), through the cores preserved by the Geological Survey, material that calls forth the following interesting remark: "It needs little imagination to picture the presence of forests of Sequoia in N. Ireland, possibly contemporaneous with those in S. Devon at Bovey Tracey, the shores of the Baltic, the Rhine valley, Saxony, Silesia, and S. France. We may yet find in Ireland large deposits of lignite or brown coal of economic value like those abroad."

THE STATEMENT OF CRYSTAL-SYMMETRY.—Numerous minerals are known, the normal crystals of which indicate, on physical measurement, a certain type of symmetry, while the results of treating them with solvents lead to their being placed in another of the thirty-two crystallographic classes. A latent symmetry is thus revealed. E. T. Wherry (*Amer. Journ. Sci.*, vol. 204, p. 237, Sept. 1922) styles such crystals *amphisymmetric*, and regards the symmetry determined with the goniometer as that of the structure built up by the atoms or molecules, and the latent symmetry as that of the separate atoms or molecules, with their attached electrons. This matter is ingeniously stated on p. 241. A halogen atom in sylvine, for example, may receive an electron from a potassium atom, and may then, as a complete octet, be capable of taking its place in a holosymmetric structure. When, however, it is attacked by a solvent, its low surface-symmetry, due to the presence of one electron of metal and seven of halogen, is revealed as the latent symmetry of the substance. Both classes of symmetry should be mentioned in the description of the crystal. Sylvine might thus be described as "Cubic; structurally holosymmetric; latently gyroidal," or "Cubic, structurally of class 32, latently 29." A useful list of amphisymmetric substances is given by the author, including some not known as minerals.

INSULATION TESTING. — Messrs. Evershed and Vignoles, Ltd., of Acton Lane Works, Chiswick, have produced a new insulation tester which possesses several advantages over the older types. Mr. Evershed, who was the first to make a testing set consisting of a small hand dynamo and an ohmmeter, has produced many improvements on the original set during the last thirty years. His greatest improvement was when he made a "one-box" instrument in 1903 and raised the pressures produced by the hand dynamo to 500, 1000, and even higher voltages. This instrument is called the "megger" and has a world-wide reputation. The new instrument is called the "meg" insulation tester. As its weight is only 7 lb. and its dimensions are only $5\frac{1}{2} \times 7\frac{3}{4} \times 6\frac{1}{4}$ inches, it is much lighter and smaller than any similar instrument. The case is made of cast aluminium, one end of which is formed of an oil-tight gear box. It is always ready for use and will stand rough usage. A free-wheel device protects the gear from damage and prevents the armature from being turned the wrong way. At 100 rev. per. min. it generates 500 volts, and considering its size its efficiency is most satisfactory. The price is only about half the price and the weight is less than half the weight of the well-known "megger" testing set.

HEATING AND VENTILATION IN PASSENGER SHIPS.—With the general advance of scientific progress many of the discomforts of sea life have been eliminated. Distilling ensured a plentiful supply of fresh water; electricity solved the problem of lighting, refrigeration that of food preservation. The accommodation of our big ships is often and rightly described as palatial. If there is any problem that has lagged behind it is that of the ventilation and heating of passenger ships, a subject which was dealt with in a paper read by Mr. J. L. Musgrave at the Institution of Heating and Ventilating Engineers on October 11. The problem is admittedly a difficult one. Not only have large numbers of passengers to be accommodated in limited spaces but the conditions of sea life change from day to day. Then, too, odours from the machinery spaces, from the paintwork, store-rooms, kitchen, bathrooms, etc., have to be prevented from reaching the living spaces, and at the same time an ample supply of fresh air, heated or cooled as the case may be, has to be kept in circulation throughout dining saloons and cabins. In his paper the author referred to these things and gave it as his opinion that though shipbuilding firms employ experienced men to design the ventilating and heating arrangements, the co-operation of the fully-qualified heating and ventilating engineer at an early stage of the design of the ship would lead to more satisfactory results, and that expenditure on improved ventilation would prove a profitable investment.

The Hydrogen Molecule.[1]

IN Prof. Crehore's papers on the hydrogen molecule, Saha's theory of electromagnetic forces is made use of, which is founded on the Einstein relativity theory. A certain type of atom is described for hydrogen, consisting of a revolving nucleus of positive electricity with two revolving negative electrons, one on either side of the nucleus, and having a common axis of revolution with it; and it is shown that the resultant of the electrostatic and electrodynamic forces acting at points the distance of which from the atom is great, compared with the distances between the atoms in a crystal, varies inversely as the square of the distance. Gravitational force is thus shown to result from the combination of electrostatic and electrodynamic forces, when relativity is taken into account. The spinning of the positive nucleus, and of the electrons, gives them an ellipsoidal form, the ratio between the major and minor diameters being in each case 3·058. For the negative electron the major diameter is $6{\cdot}514 \times 10^{-13}$ cm. and the minor is $2{\cdot}130 \times 10^{-13}$ cm. The greater part of the mass of the atom resides in the positive nucleus; and, as it is assumed to be wholly of electromagnetic origin, this nucleus is extremely minute in comparison with the negative electron, as in the commonly accepted theory of atomic structure, the solar system theory.

In the hydrogen atom, when a disturbance takes place, the electrons will move a certain distance along the common axis about which they and the positive ellipsoid are rotating, away from the latter; and will then return to their original position. Crehore is of opinion that it will be possible, in this way, to account for the emission of various kinds of monochromatic light from the atom, and that the existence of definite quanta of luminous energy may be explained. He contemplates the adaptation of the whole of the mathematics of Planck and of Bohr to his special form of atom.

The action of one hydrogen atom upon another, at a distance from it, is investigated, with the restriction that the axes of rotation are parallel to one another. Mathematical evidence is obtained of the possibility of certain definite positions of equilibrium for the second atom, in the field of the first, so that the two are bound together to form a molecule. Their distance apart appears to be of the order of 10^{-8} cm., or enormously large, when compared with the size of the atoms. The distance is of the same order as the distances between the atoms of crystals; and it is to be supposed that similar relations to those between two hydrogen atoms, in a hydrogen molecule, exist between the atoms of sodium and chlorine, in sodium chloride; and that a number of such atoms are linked up, in

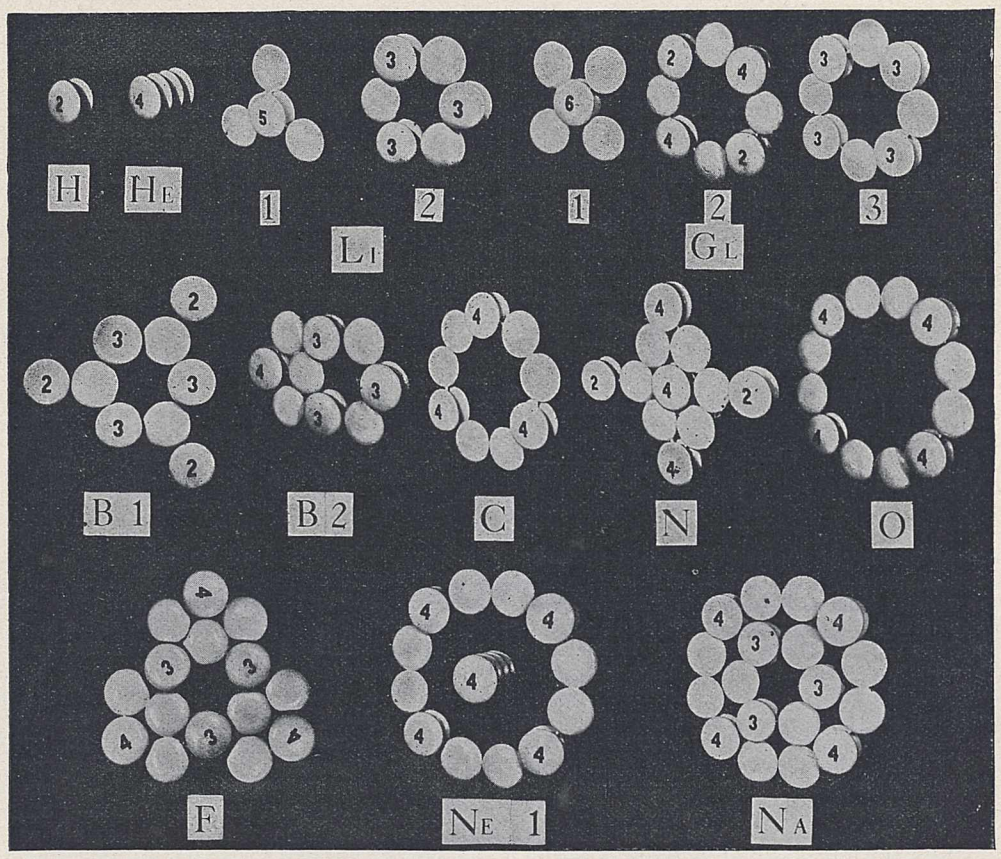

FIG. 1.—H, hydrogen atom; two coaxial, ellipsoidal electrons, on either side of positive electron with charge $+2e$, and mass 1·008. He, helium atom, four coaxial electrons with positive nucleus between them. Li 1, discarded by Crehore. Li 2, three δ particles with three binding electrons representing Li 7, N=3. Gl 1, discarded by Crehore. Gl 2 and 3 do not represent observed isotopes. B_1 and B_2, isotopes of boron B_{10} and B_{11}. C, carbon with six binding electrons corresponding to the atomic number of the element, N=6. O, oxygen, N=8, eight binding electrons. F, fluorine, N=9, nine binding electrons. Ne 1, Ne 20; the helium atom at the centre is supposed to be equivalent to an addition of two binding electrons. Na, sodium, N=11, eleven binding electrons.

[1] Prof. A. C. Crehore, *Phil. Mag.*, Oct. 1921, May 1922, June 1922.

this way, into a large compound molecule or crystal. Crehore hopes that his theory will be found capable of explaining all the properties of matter, chemical affinity, valency, and the electric and magnetic properties.

Prof. Crehore has constructed a number of models consisting of wooden ellipsoids, which represent electrons, to show the structure which he assigns to the atoms of a number of elements, including several of the isotopes, which have been observed, and the atomic weights of which have been determined by Aston and Fowler, with the positive ray spectrograph. Reproductions of some of these models appear in Fig. 1; and they account for the observed atomic weights of the different elements, including those of the isotopes as determined by Aston and Fowler. The positive nuclei do not appear in the models, as the ellipsoids of revolution representing them are very minute compared with the negative electrons. Crehore assumes the existence of three different kinds of positive nuclei; those of hydrogen, with charge $+2e$ and mass 1·008; those of helium, with charge $+4e$ and mass four; and those of a hypothetical element with charge $+3e$ and mass 2·333. In building the models these nuclei are combined with electrons as follows, to form positively charged particles; (1) that of hydrogen, with one negative electron, giving a particle H′, with charge $+e$, and marked 2 in the models to show that the charge of its nucleus is $+2e$; (2) that of helium, with two negative electrons, giving an α particle with charge $+2e$, marked 4 in the models, as the charge of its nucleus is $+4e$; (3) that of helium, with three electrons, giving a particle with charge $+e$; (4) that of the hypothetical element, with mass $2\frac{1}{3}$, together with two electrons, positive charge $+e$ and marked 3 in the models.

Calling this δ, the isotope of lithium (Li 7), with atomic weight 7, is formed by a ring of three δ particles, joined by three electrons, which may be shown developed into a straight line as $-\delta-\delta-\delta\ldots$, the full hyphens representing the binding electrons. Beryllium is assigned the structure $-4-2-4-$, the two 4 particles being joined by two electrons, and the atomic weight being nine. Be 10 is a ring $-\gamma-\mathrm{H}'-\gamma-\mathrm{H}'\ldots$. Carbon is represented as $=\alpha=\alpha=\alpha:::$, oxygen as $=\alpha=\alpha=\alpha=\alpha::::$, and neon as the same ring of four α particles, with a helium atom at its centre, the common axis of the four negative electrons and one positive particle of the helium being at right angles to the plane of the ring.

It will be understood that the γ particle is obtained from helium by removing one electron, and the α particle by removing another, from the other end of the axis, about which the electrons and the positive particle are regarded as rotating. The H′ particle, with charge $+e$, is obtained from Crehore's hydrogen atom by removing one of the two electrons on either side of the nucleus, and the δ particle will have two electrons, one on either side of the nucleus, and rotating about its axis. These α, γ, H′, and δ particles are held together by binding electrons to form the atomic models described above. The atomic number is in general equal to the number of the binding electrons.

Athletics and Oxygen Supply.

IN attempting to analyse the factors which underlie muscular efficiency, most observers have been content to concern themselves with a consideration of the oxygen supply. They have devoted themselves to a study of the means by which fuel arrives at the engine rather than to a study of the behaviour of the engine itself. As a result of the work of Fletcher, Hopkins, and of Hill, we are now in a position to consider the broad question of athletic capacity from the details of the changes which we know take place in the contraction of a single isolated muscle.

We know that during the initial contraction of the muscle and the period in which this contraction is maintained, there is a liberation of lactic acid within the muscle, and that the actual contraction of the muscle is a consequence of the physical forces called into play by the appearance of this acid at various membranes or surfaces within it. The fact of great significance is that these processes in which the full force of the muscle is developed and maintained do not demand for their accomplishment any supply of oxygen whatever. While the muscle relaxes the lactic acid present is neutralised by the supplies of available alkali in the tissues, but not until the period after relaxation is complete does the oxygen consumption of the muscle begin. In this final stage, in which the muscle is apparently at rest, a process goes on which may be compared to the recharging of an accumulator, for not only is oxygen consumed but the lactic acid disappears and heat is developed.

A little reflection is sufficient to help us to realise that the sequence of changes in the isolated single muscle, in which the oxygen consumption only occurs during the final stage, has its counterpart in the processes going on in the body of a man running a race. When the running stops, he is "out of breath," that is to say he still needs oxygen in excess of his resting requirements, for he does not, from minute to minute during the race, obtain all the oxygen necessary to oxidise the lactic acid produced in the contractions of his muscles. If he runs slowly the process of removing lactic acid will be correspondingly facilitated, for his oxygen intake will be nearly sufficient to deal with all the lactic acid produced. If, however, he runs quickly, while he does not increase his oxygen intake, he does increase his lactic acid production, and this production will soon outstrip its removal. In other words, the runner will become fatigued. Fatigue, then, is seen to be due, among other things, to the accumulation of lactic acid in the muscle, and the extent of a man's capacity as an athlete depends on the extent to which he can tolerate such an accumulation. His toleration for lactic acid will depend on the reserve of alkali which his tissues contain for neutralisation of this acid.

Prof. A. V. Hill, in a paper read before the Section of Physiology of the British Association at the recent meeting at Hull, was at some pains to point out the errors into which various observers have fallen by neglecting the oxygen consumption which takes place after running stops. They have assumed that the oxygen consumption per minute during the running represented the total energy requirement, and have in some cases arrived at the absurdity that quicker rates of running require less oxygen than do slower rates. Yet it is precisely *because* the oxygen consumption can to a certain extent lag behind the development of energy, it is *because* the isolated muscle can exert its full strength in the absence of oxygen, that a man can run 100 yards at a much greater speed than he can run 1 mile.

An interesting confirmation of the view that fatigue is due to the accumulation of lactic acid in the muscles is obtained by considering the fact that

a man of athletic frame can "run himself out" to such an extent that he requires 10 litres of oxygen at the end of exercise above his resting consumption, he will absorb this amount during the 8-10 minutes which follow the end of the exercise. Now the amount of lactic acid which this oxygen will oxidise can be calculated, and on the assumption that a man of 70 kgm. weight is using 25 kgm. of muscle, the calculation indicates that when an athletic man is exhausted, the lactic acid present will amount to 0·33 per cent. of his muscle weight. But Meyerhof has determined that the maximum percentage of lactic acid which can be produced by stimulation in isolated mammalian muscle varies from 0·3 to 0·4 per cent. The agreement between the two figures is very striking.

The fact that a runner does not consume all the oxygen he requires for running until the exercise is over may be regarded in another light. One may say that the runner gets credit for oxygen. Let us suppose that before exhaustion he can get credit for 10 litres. Then, if during exercise he breathes in 5 litres per minute, it follows that in running for 1 minute he has energy corresponding to 15 litres of oxygen at his disposal. In running for 5 minutes, however, the energy available only corresponds to $(10 + 5 \times 5 =)$ 35 litres of oxygen; that is to say, it corresponds to 7 litres per minute. Roughly speaking, the energy available per minute when running 5 minutes is less than half that available when running only 1 minute.

It was found to be possible to plot a curve showing the relation of the true oxygen consumption in running various distances at a maximum rate to the time taken. The distances chosen were those of the customary flat races. It was found that the curve was of the same general type as that obtained when the speed developed in the various world's records was plotted against the time taken. In other words, it was evident that the shape of this latter curve could have been predicted from considerations of oxygen consumption.

The Fiftieth Anniversary of the Dutch Zoological Society.

THE fiftieth anniversary of the foundation of the Nederlandsche Dierkundige Vereeniging, which was celebrated at Amsterdam on September 24 and 25, was an event of much scientific interest.

At the meeting held in the large hall of the Amsterdam Zoological Gardens ("Natura magistra Artis") the president, Prof. J. F. van Bemmelen, of the University of Groningen, delivered an interesting address on the history of the Society. He referred in the course of his address to the important part the Society has played in the scientific investigation of the Dutch marine fauna and flora and in the establishment of the permanent Marine Biological Station at Helder, to the activity it has shown in the movements for the preservation and protection of native wild animals and to its association, in an advisory capacity, with Dutch Government Departments on questions concerning the scientific development and regulation of the marine and fresh-water fisheries.

At the conclusion of his address the following were admitted Honorary Members of the Society: Prof. O. Abel, Vienna; Prof. M. Caullery, Paris; Prof. L. Dollo, Brussels; Prof. B. Grassi, Rome; Prof. V. Häcker, Halle; Prof. S. J. Hickson, Manchester; Prof. N. Holmgren, Stockholm.; Prof. T. H. Morgan, New York; Dr. F. Sarasin, Basle; Dr. J. Schmidt, Copenhagen.

On the following day, September 25, a large party of the members with their foreign guests set forth from Amsterdam in a steamboat through some of the most interesting and beautiful waterways of that part of the country to visit the new Fresh-water Biological Laboratory stationed in the river Vecht near Vreeland. A large and commodious houseboat called the *Meerval* has been fitted up with aquaria, dredging apparatus and other appliances for systematic and biometrical investigations of the fresh-water fauna, and there is sleeping accommodation for two or three investigators and the staff. The *Meerval* can be moved about from place to place during the summer months and is laid up for the winter at Helder.

The party was received on board the *Meerval* by Dr. Redeke, the director of the Marine Biological Station and Inspector of Fisheries, who gave an account of the investigations in progress and explained the exhibits and apparatus that were displayed.

One important result of the activities of Dr. Redeke and his assistants will be the publication of periodical reports on the fauna and flora of the Zuider Zee, and particularly of that part of it which is threatened with destruction by draining. An advanced copy of the first number of these reports was shown to the visitors.

The members of the society and their guests were entertained on the Sunday night at a banquet in Amsterdam, and on the Monday were the guests of Dr. and Mrs. Redeke at lunch at Vreeland.

It was unfortunate that Prof. Caullery (Paris), Prof. Dollo (Brussels), Prof. Grassi (Rome), Prof. Morgan (New York), and Dr. Schmidt (Copenhagen) were unable to attend the celebrations; but the foreign guests who were present thoroughly enjoyed the opportunity thus given to them by their most hospitable Dutch hosts of an interchange of views on zoological problems with friends and colleagues they had not met since pre-war days.

We may congratulate the Dutch Zoological Society on the attainment of its fiftieth anniversary, and on the valuable scientific work it has accomplished since its foundation.

Processes of Rock-Formation.

IN a long communication sent to us by Mr. J. H. Goodchild, dealing with the distribution of sodium and calcium, reference is made to Prof. J. Joly's calculation of the age of the earth from the saltness of the sea, a calculation based on the assumption that the salt in the sea has been carried there by streams and rivers and has been derived by solution from the land. In opposition to this view Mr. Goodchild suggests that, contrary to the notions held at the present day by geologists, salts pass from the ocean to the land, and are being fixed as new mineral combinations in the rocks through which they percolate. He regards sedimentary rocks, such as sandstone and shale, as unstable, and liable to admixture with one another as well as to modification by the action of soluble substances like salt and calcium carbonate. As examples of changes of this sort he points to the dolomitisation of limestone, the

formation of hæmatite at and near the surface, concretions in the coal measures, and vein formations of quartz, calcite, fluorspar, and barytes.

Mr. Goodchild extends this conception to the formation of metamorphic rocks, which he regards as being formed by the action of percolating solutions on unstable strata, the action of heat and pressure being an accompaniment rather than, as petrologists usually assume, the cause of the metamorphism. From this position, assuming the formation of aluminium silicates at low temperatures, Mr. Goodchild has no difficulty in explaining the formation of basalt and other igneous rocks as due to the local but intensive action on sedimentary rocks such as sandstone, shale, and limestone of solutions containing sodium, potassium, magnesium, and calcium. Hence where igneous rocks are found associated with sedimentary rocks Mr. Goodchild regards the former not as pre-existing igneous or other rocks that have been melted by heat and injected into the sediments in a molten state, but rather as portions of the sediments that have been altered locally by interaction with one another and with percolating solutions.

According to Mr. Goodchild, rock-changes in temperate climates show ample evidence of the process to which he refers, but he states that these changes are best seen under tropical conditions. He makes a strong plea for the representation in colour of tropical conditions of weathering, by artists imbued with a sense of mystery, as a means whereby observers in temperate climates may be brought to realise the real nature of the processes involved in metamorphism and the origin of igneous rocks.

For fuller details as to Mr. Goodchild's views, reference may be made to papers on "Laterization in Minas Geraes, Brazil" (Trans. Inst. Min. Met., 1914, vol. 23, p. 3), and "Land Growth" (*Mining Magazine*, 1921, vol. 25, p. 75).

University and Educational Intelligence.

BIRMINGHAM.—We recently announced in this column the appointment of Mr. K. N. Moss as professor of coal- and metal-mining. This appointment has now been followed by the creation of a chair of petroleum-mining, to which Mr. R. R. Thompson has been elected. Prof. Thompson was on the staff of the mining department of the University during the session 1911–12, since when he has had experience of oil-mining in Persia, Burma, and elsewhere. He has recently been Director of Lands and Mines in Trinidad, a post which he relinquished to come to Birmingham. Sir John Cadman continues to act as honorary adviser to the mining department, and with Dr. Haldane as director of Coal-mining Research, the University takes a very high place as a centre of instruction in mining in the British Empire.

CAMBRIDGE.—Prof. H. R. Dean, professor of pathology, has been elected to a professorial fellowship at Trinity Hall. Prof. R. M. Dawkins, of Oxford University, formerly director of the British School at Athens, has been elected to an honorary fellowship at Emmanuel College, where he was formerly a fellow. The Master of Jesus College has been appointed to represent the University on a grand committee established to make arrangements for the commemoration next February of the bicentenary of the death of Sir Christopher Wren.

Mr. F. G. Mann, Downing College, has been appointed assistant to the professor of chemistry. The Gedge Prize has been awarded to F. J. W. Roughton, Trinity College, for an essay on "Some Blood Gas Problems."

LONDON.—At a meeting of the Senate held on October 18, a communication was received from the Minister of Health forwarding draft heads of agreement with reference to the School of Hygiene which is to be established as a School of the University with the donation of two million dollars made for the purpose by the Rockefeller Foundation. These provide for the erection of suitable buildings on a site in Bloomsbury and the constitution of a Board of Management and a Court of Governors for the control and administration of the School. Resolutions were adopted expressing the concurrence of the University in the proposed scheme, and the very great satisfaction with which the Senate have learnt of the munificent contribution of the Rockefeller Foundation and of the intentions of the Government with regard to the maintenance of the School.

To a communication from the Clerk of the London County Council intimating the desire of the Council that the question of the Bloomsbury site for the University should be reopened, the Vice-Chancellor was requested to reply that the Senate is prepared, "should His Majesty's Government wish to explore the possibilities of the Holland Park Site or any other site in conjunction with the University, to co-operate with the Government for that purpose."

The thanks of the Senate were accorded to the Essex County Council for a grant of 500*l.* for the year 1922–1923 for distribution among the Schools of the University in the Faculties of Arts, Science, Engineering, and Economics in proportion to the number of full-time day students from that county in attendance at those Schools; also to the Stansfeld Trustees for a second donation of 40*l.* for the provision of a Stansfeld lecture to be delivered on the laws and customs affecting the relationship between men and women.

The following doctorates were conferred: *D.Sc. in Chemistry*: Mr. S. S. Bhatnagar, of University College, for a thesis entitled "Studies in Emulsions and Surface Tensions"; Mr. F. C. Toy, of University College, for a thesis entitled "Investigations of the Photographic Process"; and Mr. H. Moore, for a thesis entitled "The Influence of Chromium on Steel," and other papers; *D.Sc. in Physics*: Mr. Snehamay Datta, of the Imperial College, Royal College of Science, for a thesis embodying the results of various researches in spectroscopy

A course of eight free public lectures on "Secretion and Internal Secretion" will be delivered by Prof. Swale Vincent on November 6, 9, 13, 16, 20, 23, 27, and 30, at 5 o'clock, in the Physiology Lecture Theatre, Middlesex Hospital Medical School, Union Street, W.1. No tickets will be required.

A CONFERENCE on the report of the committee appointed by the president of the Board of Education to inquire into the position of English in the educational system of England will be held at Birkbeck College, Bream's Buildings, Chancery Lane, E.C.4, on Thursday, November 2, at 4.30. The chair will be taken by Sir Cyril Jackson, chairman of the Education Committee of the London Council.

THE University of Bristol Association of Alumni (London branch) has arranged to hold an inaugural dinner at La Renommée Restaurant, 52 Dean Street, Shaftesbury Avenue, London, on Monday, November 6, at 7.30 P.M. Lord Haldane is the president of this branch, and it is hoped that a large number of members of the University, both past and present, will be at this dinner. The Vice-Chancellor and Mrs. Loveday have already accepted an invitation to attend.

Calendar of Industrial Pioneers.

October 29, 1874. John Laird died.—One of the chief pioneers of iron shipbuilding, Laird, who was born in Greenock in 1805, was the son of William Laird, who established a boiler-making works at Birkenhead. As a partner with his father, in 1829 he built an iron lighter of 60 tons, and in 1833 built the iron paddle steamer *Lady Lansdowne*. Laird also built the first iron vessel in the Royal Navy, and in 1839 built the *Nemesis* for the East India Company, the first iron steamer to carry a gun and to steam round the Cape. The famous Birkenhead Iron Works were established by him.

October 30, 1823. Edmund Cartwright died.—The inventor of the power loom, which he brought out in 1785, Cartwright was born in the Midlands in 1743, was a student of University College, Oxford, and entered the Church. While holding the living of Goadby-Marwood in Leicestershire a visit to Arkwright at Matlock turned his attention to weaving, and within a year he had made the great invention by which he is remembered. His loom was employed but little till the 19th century, but in 1809 he was granted a sum of 10,000*l.* by Parliament. Cartwright also made improvements in woolcombing and in agriculture, and assisted Fulton in some of his experiments in steam navigation.

October 30, 1880. Sir Thomas Bouch died.—Born in Cumberland in 1822, Bouch was trained as a railway engineer and in 1849 became manager of the Edinburgh and Northern Railway. He constructed some 300 miles of railway, instituted steam ferries on the Forth and Tay, and between 1870 and 1877 built the first Tay Bridge, nearly two miles long. This bridge consisted of 85 spans, some of the wrought-iron lattice girders being 245 feet long. It was completed in September 1877, and opened for traffic in May 1878. During a hurricane on the evening of December 28, 1879, the central portion with an entire train and 70 passengers fell into the Tay.

October 30, 1898. Josiah Latimer Clark died.—A distinguished electrical engineer, Clark began life as a chemist, and after engaging in railway work, in 1850 joined the Electric and International Telegraph Company. His principal work lay in the field of submarine telegraphy and he was concerned with the laying of many cables, mainly in the East. He was also an original investigator, assisted to found the Institute of Electrical Engineers, and in 1874–75 served as president.

November 1, 1856. John Urpeth Rastrick died.—Trained under his father as a mechanical engineer, Rastrick took an important part in introducing railways into the country. He effected improvements in locomotives, was one of the judges at the Rainhill trials of 1829 who decided in favour of Stephenson's *Rocket*, assisted Stephenson to survey the Birmingham and Manchester Railway, and with Sir John Rennie was engineer to the London and Brighton line.

November 4, 1917. William Du Bois Duddell died.—Recognised as a brilliant investigator of electrical phenomena, Duddell was trained as an engineer at Colchester and then worked under Ayrton at the Central Technical College, London. His discovery of the singing arc formed the starting point in the development of the Poulsen arc, while his oscillograph marked an epoch in the experimental investigation of alternating current phenomena. He was a Fellow of the Royal Society and served as president of the Röntgen Society and of the Institution of Electrical Engineers. E. C. S.

Societies and Academies.

LONDON.

Optical Society, October 12.—Prof. F. J. Cheshire, vice-president, in the chair.—L. C. **Martin**: A physical study of coma. A specially designed microscope objective and mounting, calculated to exhibit coma in the absence of spherical aberration and astigmatism, are described. Photographs of a star image, taken when the amount of coma is equivalent to that for which the light distribution has been calculated, verify the numerical work. The photometric examination of the photographic image is carried out by a special method.—F. W. **Preston**: Comparison of the structure of sand-blasted and ground glass surfaces. Glass surfaces smoothed or "greyed" by loose abrasives in the usual way are compared with those produced by sand blasting. The surfaces are practically indistinguishable either by the naked eye or the microscope, and the development of the structure by etching shows that the structure is virtually identical. Thus it appears that mere pounding of a glass plate can, and does, produce a surface which is structurally indistinguishable from a smoothed surface of a technical order.

PARIS.

Academy of Sciences, September 18.—M. Emile Roux in the chair.—L. **Cuénot** and Raymond **Poisson**: The development of some coaptations of insects. Coaptations are defined as mechanical arrangements formed by the reciprocal adjustment of two independent parts, like a key and a lock. Examples of such processes are given from *Nepa cinerea* and *Ranatra linearis*.—L. G. **Du Pasquier**: The arithmony of quaternions.—Jean **Rey**: The probability of illuminating an aeroplane by the beam from an electric projector.—A. **Sanfourche**: The reactions between the gaseous oxides of nitrogen and alkaline solutions. The reaction generally assumed to take place occurs only when the alkali is in excess at every point. If there is any local deficiency of alkali, the gas reacts with water producing nitric acid and nitric oxide. Sulphuric acid is preferable as an absorbent.—Paul **Riou**: The velocity of absorption of carbon dioxide by ammoniacal solutions. Experimental results on the velocity of absorption of carbon dioxide by solutions of ammonium carbonate, with varying concentrations of salt and with varying temperatures.—P. **Russo**: New indications of the Trias in eastern Morocco.—Jean **Bathellier**: The rôle of the soldiers in *Eutermes matangensis*. In fighting, the soldiers of this species eject a sticky fluid, insoluble in water, which rapidly reduces their opponents to immobility. If the nest is broken, the workers are protected during the process of reconstruction by a line of soldiers, which follows the contour of the gallery under repair.—F. **Dienert** and P. **Etrillard**: The possibility of the existence of organisms in rocks capable of reviving after sterilisation by heat. A repetition of some experiments by M. Galippe. The results of M. Galippe were not confirmed: the rocks were sterile after prolonged heating to 180° C.

September 25.—M. L. Maquenne in the chair.—The Perpetual Secretary announced the death of M. Battandier, correspondant for the section of Botany.—P. **Urysohn**: The ramification of the Cantorian lines.—M. **Seigle**: The principal characteristics of mild steel bars previously broken by traction. It has been generally held that a steel hardened by extension is breakable and dangerous to use. Tests

on bars of mild steel broken by pulling show that this view is not exact. Details of the various tests to which the bars were submitted are given.—P. **Chevenard**: Nickel alloys retaining their rigidity over an extended temperature range. The alloy in the form of wire was heated to a constant temperature and loaded with a weight: an automatic arrangement recorded photographically the elongation as a function of the time. Curves are given for nickel, electrolytic iron, and for four alloys. A nickel-chromium-tungsten alloy was the most resistant to high temperatures.—L. J. **Simon**: The direct oxidation by oxygen or air of the esters of the alcohol acids. Methyl, ethyl, butyl, and amyl lactates when heated in a current of air undergo oxidation, giving the pyruvates in notable proportion. Ethyl glyoxylate can similarly be recognised as one of the products of oxidation by air of ethyl glycollate.—E. **Fournier**: The nature and structure of the substratum of the Jura chain. An account of the strata pierced by an experimental boring at Chazelot (near Rougemont) carried to a depth of 700 metres.—L. **Eblé**: Magnetic measurements in the Paris basin. The results given for 41 stations form part of a new magnetic survey of France. The secular variation of the magnetic elements between January 1, 1896, and January 1, 1922, was practically the same for all the stations; the mean values were: declination $-2° 58'$, inclination $-0° 32'$, horizontal component $+0{\cdot}0014$. These are almost exactly the values obtained at the central station of Val-Joyeux.—Marcel **Mirande**: The influence of light on the formation of anthocyanine in the scales of the bulbs of lilies. It has been shown experimentally that the only radiations taking an active part in the reddening of the scales are those in the luminous part of the spectrum: there is a first maximum effect in the red, a much more important maximum in the indigo blue, and a minimum in the green.—L. **Berger**: The existence of an ovarian gland, homologous with the testicular interstitial gland.—L. **Carrère**: The dilator of the pupil in the selacians.—Paul **Wintrebert**: The cartilaginous pterygoid in the urodeles.

SYDNEY.

Royal Society of New South Wales, September 6.—Mr. C. A. Sussmilch, president, in the chair.—R. H. **Cambage**: Acacia seedlings, Pt. VIII. A number of seedlings of different species were described. A seed of *Acacia melanoxylon* germinated after having been continuously immersed in sea water for five years. The phyllodes of various species of Acacia, such as *A. conferta*, *A. elongata*, *A. floribunda*, and *A. longifolia*, close up towards the stem at night.—M. B. **Welch**: Relationship between oil glands and oil yields in the Eucalyptus. Measurements made of the oil glands in the leaves of different Eucalypts show that the oil yield on distillation is not absolutely dependent on the number and size of the oil glands.—S. **Dodd**: Poisoning of sheep by *Solanum cinereum*. Feeding experiments proved the berries to be very poisonous. The active principle is probably solanin. Half a pound of dried ripe berries given whole were innocuous, but the same amount mashed with water caused death to sheep in six hours. The probable reason for this is that when dry and whole they passed into the rumen, where they became mixed with other food; at the end of each rumination the total amount of fruits re-swallowed was insufficient to produce poisoning. In the other case the soluble alkaloid passed direct into the digestive stomach, etc., and the amount absorbed, being lethal, death resulted.

Diary of Societies.

MONDAY, OCTOBER 30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Specimens of Foreign Bodies.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—W. B. Appleton: Past and Present Methods of making Photographic Lenses.

TUESDAY, OCTOBER 31.

ROYAL HORTICULTURAL SOCIETY, at 3.—C. T. Musgrave: Methods of Propagation in an Amateur's Garden.

WEDNESDAY, NOVEMBER 1.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—C. Ainsworth Mitchell: The Colorimetric Estimation of Pyrogallol, Gallotannin, and Gallic Acid.—Dr. H. E. Annett and M. N. Bose: The Estimation of Narcotine and Papaverine in Opium.—J. R. Nicholls: The Estimation of Morphine.—R. L. Morris: Further Notes on the Estimation of Potassium; by Perchlorate and Cobaltinitrite Methods.

THURSDAY, NOVEMBER 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Lord Rayleigh: Polarisation of the Light scattered by Mercury Vapour near the Resonance Periodicity.—Prof. G. P. Thomson: The Scattering of Hydrogen Positive Rays and the Existence of a powerful Field of Force in the Hydrogen Molecule.—H. D. Smyth: A new Method for studying Ionising Potentials.—I. Backhurst: Variation of the Intensity of reflected X-radiation with the Temperature of the Crystal.—S. Datta: The Absorption Spectrum of Potassium Vapour.—K. R. Ramanathan: The Molecular Scattering of Light in Vapours and in Liquids and its Relation to the Opalescence observed in the Critical State.

LINNEAN SOCIETY, at 5.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Sir Maurice Craig: Mental Symptoms in Physical Disease (Bradshaw Lecture).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major A. R. Low: A Review of Airscrew and Helicopter Theory, with Aeroplane Analogies.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. P. B. Ballard: A Defence of Mental Tests.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. Gill: Inaugural Presidential Address.

CHEMICAL SOCIETY, at 8.—N. V. Sidgwick and W. M. Dash: The Solubility and Volatility of the Nitrobenzaldehydes.—R. H. Pickard, J. Kenyon, and H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XIII. The Spatial Configuration of the Unbranched Aliphatic Chain.—J. Kenyon and R. A. M'Nicol: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XIV. The Normal Aliphatic Ethers of *d*-β-octanol.—H. Phillips: Investigations of the Dependence of Rotatory Power on Chemical Constitution. Part XV. The Normal Aliphatic Ethers of *d*-methylbenzylcarbinol.—H. Phillips: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XVI. A new type of Walden Inversion.—L. Hall: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XVII. The *di*-*d*-β-octyl Esters of the Acids of the General Formula $(CH_2)_n(COOH)_2$.—F. L. Pyman: Orientation of the 1: 4- and 1: 5-dimethylglyoxalines. Mode of Fission of 5-aminoglyoxalines.—L. Light and F. L. Pyman: Bromo-derivatives of 2-methylglyoxaline.

INSTITUTION OF BRITISH FOUNDRYMEN (at Institute of Marine Engineers), at 8.—F. A. Melmoth: Notes on the Development of the Manufacture of Steel Castings.

FRIDAY, NOVEMBER 3.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Sir Frank Baines: Repairs to the Roof of Westminster Hall.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—T. H. Sanders: Laminated Springs.

PUBLIC LECTURES.

SATURDAY, OCTOBER 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: The Life and Habits of Mason Wasps.

MONDAY, OCTOBER 30.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir William M. Bayliss: The Unity of the Human Body.

WEDNESDAY, NOVEMBER 1.

UNIVERSITY COLLEGE, at 5.30.—Dr. P. Harting: Holland, the Land and its People.—S. Jones: Some Recent Results in Experimental Phonetics.

THURSDAY, NOVEMBER 2.

FINSBURY TECHNICAL COLLEGE, at 4.—Prof. C. H. Desch: The Metallurgical Chemist (Streatfeild Memorial Lecture).

UNIVERSITY COLLEGE (in Physics Lecture Theatre), at 5.30.—Prof. E. G. Coker: Recent Photo-Elasticity Researches in Engineering Problems.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Prof. H. Maxwell-Lefroy: How Insect Pests are tackled.

FRIDAY, NOVEMBER 3.

BEDFORD COLLEGE FOR WOMEN, at 5.30.—Miss C. A. J. Skeel: Ancient Travel.

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: The Philosophy of Religion. Succeeding Lectures on November 10, 17, 24, December 1 and 8.

SATURDAY, NOVEMBER 4.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Folklore of the Cat.