THURSDAY, OCTOBER 26, 1911.

AGRICULTURE IN DRY COUNTRIES.

Dry Farming: a System of Agriculture for Countries under a Low Rainfall. By Dr. J. A. Widtsoe. Pp. xxii+445. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 6*s.* 6*d.* net.

ACCORDING to the author's calculations, nearly six-tenths of the land surface of the earth receives less than twenty inches of rain per annum, and therefore requires the adoption of special agricultural methods differing from those in use in moister regions. In the strict historical sense it may be that the "dry farming" methods are really the older, for some of the ancient civilisations—Babylon and Egypt—flourished in "dry" regions. But to-day the dry farming methods are new, and are rapidly being extended over the regions of deficient rainfall that are now coming into cultivation.

Dry farming is different from irrigation, which is not touched upon in the present book. It consists in cultivation methods that reduce the loss of water from the soil by evaporation, and thus leave a maximum amount for the crop. Hence it implies a certain rainfall; at least ten inches a year are wanted, and success is not certain with less than fifteen inches.

A clear account is given of the differences between the soils of semi-arid and of humid regions, so far as these can be connected with the differences in rainfall. In humid regions the fertility of the soil is largely bound up with the clay fraction; a good deal of washing has gone on, and there is a tendency for the clay to wash into the subsoil, thus limiting the distance to which air can penetrate. A sharp distinction therefore arises between the surface and the subsoil, the latter being unsuited to plant growth. In semi-arid regions, on the other hand, the washing is reduced to a minimum; clay does not wash into the subsoil (it is said that clay does not even form to any great extent, but no evidence is set forth), and the difference between surface and subsoil does not arise; hence all parts of the soil are adapted to plant growth. Two deductions are drawn: the semi-arid soils are richer in plant food and stand in less need of fertilisers than humid soils; and recourse can be had more freely to deep ploughing.

Dry farming in the States, in its modern sense, is said to have been begun by Brigham Young and his followers when, in 1847, they went into the Great Salt Lake Valley. In this arid region starvation seemed to be the only possible ending to the colony, but suitable methods of farming were gradually evolved, and the results are matters of history. But the methods were not put together until H. W. Campbell, in 1895, published his "Soil Culture and Farm Journal." Then a boom began. The railway companies, with true commercial instinct, set up demonstration farms in dry regions for the benefit of intending settlers, and glowing accounts were given of what dry farming methods would do. The question aroused great interest in the British colonies, where large semi-arid tracts occur, and commissions and deputations were sent to study the methods on the spot. It is unfortunate that commercial interests were ever involved, because for a time the whole system was looked on with considerable suspicion by agriculturists, but Mr. Widtsoe's book will go far to satisfy the most sceptical that the methods are really effective.

Naturally there has been a good deal of change in methods, but the general conclusions to which Mr. Widtsoe is led are as follows. The soil should be a clay loam, uniform to a depth of at least eight feet. After the land has been cleared and broken it should lie fallow for one year, all weeds being rigorously hoed down; it should then be ploughed deeply in autumn. If crops are to be sown immediately (as they should be if the winter season is not too cold) the plough is followed by the disk cultivator and the harrow; if not, the land should lie up rough during winter, be further ploughed in spring, disk cultivated and harrowed. After every shower of rain the land is to be cultivated; the hoe or the harrow must be kept going all the season, and directly after harvest the land must be disked. Two great principles are that a fine layer of dry soil is to be maintained on the surface; and every weed must be killed.

It was originally thought necessary to compress the soil below this surface layer, but later experience shows this operation to be superfluous. A recent development, however, is the summer-cultivated fallow, adopted every third or fourth year in regions of fifteen to twenty inches rainfall, and every alternate year in regions of less than fifteen inches rainfall. By constant cultivation a large proportion of the rainfall can be kept in the soil for the next crop.

Wheat is the best crop, maize the second best; but a rotation is desirable, including a leguminous crop. As cattle cannot be kept the straw is not wanted; the grain is therefore cut off with a "header" and the straw ploughed in. Up to the present fertilisers have not been used, and the soil, so far from showing signs of impoverishment, is said actually to increase in fertility. However, the author does not counsel disuse of fertilisers, but insists that the soil must give out unless manure is added.

The necessity for a summer fallow arises from the fact that crop production is only possible where sufficient moisture is present. It is particularly to be noticed that no economy is attempted so far as the plant itself is concerned: extraneous sources of loss only are cut off.

As in other branches of agriculture, the facts are ahead of the hypothesis. The distribution of water over a complex mass of particles like the soil has not been worked out, but it is clearly regulated by the surface attractions between the particles and the water. Further, it is supposed that evaporation takes place only at the surface, and scarcely at all—only about 0·2 inch per annum—from the layers below, but this supposition is a little difficult to reconcile with the phenomena of diffusion of air into the soil.

Soil students and agriculturists will welcome the book as a useful summary by a man on the spot of what has been achieved so far, and they will be put in a position better than before to disentangle the real from the imaginary in the accounts of dry farming they come across.

E. J. R.

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THE GROUSE AND ITS AILMENTS.

The Grouse in Health and in Disease: being the Final Report of the Committee of Inquiry on Grouse Disease. Two vols. Vol. i., pp. xxiii+512. Vol. ii., appendices, pp. vii+140+11 plates (41 maps). (London: Smith, Elder, and Co., 1911.) Price 2*l.* 2*s.* net.

ALTHOUGH, as its name implies, the Grouse Disease Inquiry Committee was formed to investigate the nature and causes of the mortality which has been so prevalent of late years in the one species of game bird peculiar to the British Isles, it has accomplished a great deal more than this. For in the handsome volumes before us we have the life-history and organisation of the grouse, coupled with those of the various parasites by which it is infested, described in a manner never before attempted in the case of any other wild bird. This magnificent piece of work, it should be added, has been carried out from start to finish by private effort and enterprise; for although the committee was officially appointed by the Board of Agriculture and Fisheries in the spring of 1905, its funds have been entirely furnished by private subscriptions. The whole investigation is, indeed, a striking, and we believe, a unique example of what can be done by the combined efforts of sportsmen, gamekeepers, field-observers, and biological experts; and to Lord Lovat, the chairman, and all those who have worked with him are due the gratitude of naturalists and sportsmen, not only in the British Islands, but throughout the world.

The first volume opens with an introduction by Lord Lovat, in which are recorded the formation of the committee, the scope of the inquiry, and a general summary of the results of the investigation. Then follow six chapters by various experts dealing with the natural history of the grouse in its normal condition, among which special reference may be made to Mr. E. A. Wilson's elaborate and careful account of the changes of the plumage, both in health and in disease. Since, however, much of this has already appeared in the Zoological Society's Proceedings, it will be familiar to many of our readers. Part ii., containing ten chapters, is devoted to the diseases of the grouse; while the third part, with the remaining seven chapters, treats of the management and economic aspects of grouse-moors. The second volume, containing only 150 pages, is devoted to lists of the names of the committee, correspondents, and subscribers, together with a number of statistical tables.

Since various notices of the progress of the inquiry have appeared from time to time in NATURE, the present review must be short. It will accordingly suffice to mention that grouse suffer chiefly from two diseases, namely, strongylosis, due to a thread-worm, *Trichostrongylus pergracilis,* and the so-called coccidiosis, caused by the sporozoon now known as *Eimeria avium.* The former attacks adult birds, and may accordingly be regarded as the chief cause of the great epidemics of "grouse disease" which have in past years wrought such destruction. The latter, on the other hand, as has been recently mentioned in our "Notes" columns, in connection with a paper by Dr. Fantham on coccidiosis in poultry, confines its attacks to young birds, which are either killed outright or recover; this disease, which was discovered during the investigation, can, therefore, have little or nothing to do with the great epidemics among adult birds. In the report the parasite of coccidiosis is referred to as *Eimeria* (*Coccidium*) *avium.* This, we may point out, is misleading, since to the systematist it would indicate that Coccidium is a subgenus of Eimeria, whereas it is really a synonym of the latter which has been discarded on grounds of priority. If this rejection be definitely accepted, we may suggest that it would be advisable to rename the disease eimeriosis, since it is obvious that if there be no such genus as Coccidium the retention of the name coccidiosis is illogical. There would, moreover, be the further advantage that we should have but one name to remember in place of two. For a somewhat similar reason, Dr. Shipley suggests on p. 207 of the first volume that strongylosis should be renamed trichostrongylosis, although there is the genus Strongylus.

The account of the life-history of the thread-worm of the grouse is written by Dr. R. T. Leiper; Dr. Shipley communicating a general account of the group (Nematoda) to which it belongs. The sporozoon (Eimeria) is discussed by Dr. Fantham, whose article appeared previously in the Proceedings of the Zoological Society. As mentioned in the "Notes" columns of NATURE some time ago, this intestinal parasite especially affects the duodenum and cæca (unusually long in the grouse), and has two developmental phases, namely, an asexual schizogony, and a sexual form in which cysts and spores, suited to a life outside the host, are produced.

Of less importance, from the point of view of the sportsman, are the tapeworms of the grouse, which are described by Dr. Shipley. Although the birds are attacked by three species of these organisms, two only need be mentioned here, namely, the large *Davainea urogalli* and the small *Hymenolepis microps,* of which the latter is by far the more dangerous to the life of its victims.

As regards future prospects, the great hope appears to lie in the proper method of managing the moors.

"To put it briefly and in practical language," writes Lord Lovat, "moor-management is the science of distributing the stock of birds over the moor, so that at no period of the year can any area be so infested by the strongyle worm as to make it a source of danger to the least well-nourished bird in that area."

R. L.

CLIMATIC CHANGE.

Palestine and its Transformation. By Prof. E. Huntington. Pp. xvii+443. (London: Constable and Co., Ltd.; Boston and New York: Houghton, Mifflin and Co., 1911.) Price 8*s.* 6*d.* net.

SEVERAL years of travel in Asia Minor, Persia, India, and central Asia, and a prolonged study of the arid and semi-arid regions of those lands, have furnished Prof. Huntington with special qualifications for investigating the effect of physical environment on human distribution and modes of life and thought in Palestine, where history reaches back to a far remoter period than in most lands. Eight months of the spring and summer of 1909 were spent in traversing the country in many directions; and since the rainfall was exceptionally deficient in the early months of that year, the struggle for subsistence on the margins of the more arid portions was strongly emphasised.

The first half of the book deals with the form of the different parts of Palestine, and its relation to the geological structure on one hand, and the distribution, occupation, and past history of the inhabitants on the other. It is this physical basis that distinguishes the present volume from many descriptions of the same region. The isolated plateau of Judæa is indicated as the heart of the land from its isolated and uplifted position, in which it stood apart from the great highways of trade which passed to the north and to the south of it, while the moisture from the Mediterranean gave it a moderate fertility. On the west the broken foothills of the plateau form a transition zone, the Shephelah, between the plateau and the coastal plain alternately controlled by the Hebrews of the highland and the Philistines of the sea margin. But on the west, facing the valley of the Jordan on the leeside of the plateau, rainfall rapidly diminishes, and the desert conditions are sharply contrasted with the comparative fertility of the Shephelah but five and twenty miles away. Similarly the present form of Samaria, due to original folding worn down by erosion to a peneplain which has since been elevated and partially dissected, has opened this portion of the land to the peoples of the East, the coast-dwellers, and traders from Africa, so that the great trade routes and the routes of armies passed through it. The peculiar characteristics of Phœnicia, of Bashan, of Galilee, of the Dead Sea depression and the neighbouring deserts, are in like manner brought out and illustrated by the author's own travels through them and the incidents therein noted, presenting a most vivid picture of the land and the influence of its form on the history of its inhabitants.

In the second half of the book Prof. Huntington treats more especially of the climate of Palestine and reviews the present-day conditions, which he contrasts with the more favourable ones which existed, in his opinion, at an earlier date. He has put forward the same hypothesis in relation to central Asia, Greece, and Asia Minor, on previous occasions, giving numerous data in support of a modification of climatic conditions during the past twenty or thirty centuries. The lines of evidence reviewed are (1) the density of the population of Palestine at various periods; (2) the distribution of woodland; (3) ancient migrations, trade routes, and lines of invasion; (4) the distribution, location, and water-supply of abandoned sites; (5) the fluctuations of the Dead Sea.

Under the semi-arid conditions which prevail over the greater part of the country, and the strictly seasonal character of the rainfall, even small departures from the normal amount react powerfully on the economic conditions throughout the area, so that there must always be a strong inclination to postulate definite deterioration of climate where signs of former occupation now abandoned are to be seen. Some of the caravan routes in northern Africa, now but little used, give little sign of their practicability for the great caravans which we know used them a few decades ago, but which altered economic conditions have suppressed. Human settlements cannot always furnish evidence that all in a given spot were occupied at the same time, and the preservation of perishable objects affords some testimony that past rainfall was not of great abundance. The author argues that there have been pulsations in the rainfall, dry periods succeeding others of greater humidity; and that, on the whole, in Palestine a diminution of rainfall from the earliest historical times to the present era has been in progress, while the pulsations within these periods often coincide with great race movements.

The importance of these alternations of dry and humid periods of moderate intensity will be generally admitted, and on the margins of desert regions the effects will be most strongly marked; but while their reality is beyond question, and the evidence for a certain decrease in the average total rainfall from the earlier historic times to the present day is obtainable in certain areas, the direct connection of race movements with such climatic variations at certain periods of history seems to be scarcely established as yet. But in any case, a most valuable summary of the subject as it relates to Palestine is given, and a survey of the history of it and the surrounding lands furnishes occasion for indicating race movements and events which apparently coincide with more or less favourable conditions of climate. An orographical map, as well as a photograph of a model of Palestine, enables the form of the land to be appreciated, and the photographs are most instructive, though the geographer will wish they had been larger. The diagrams in the text suffer from the paper being unsuited to this form of illustration.

H. G. L.

A GUIDE TO ELECTRICAL TESTING.

Testing of Electromagnetic Machinery and other Apparatus. By B. V. Swenson and B. Frankenfield, assisted by J. M. Bryant. Vol. ii., Alternating Currents. Pp. xxvi+324. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 11*s.* net.

"THE efficient direction of any industry to-day demands a very large amount of technical knowledge which cannot be learned at the bench or in the shops."

With this quotation, taken from the writings of Prof. J. B. Johnson, the authors dedicate their work to his memory, and this also gives the keynote to the book. It is essentially a guide to electrical testing, so that the reader may be fitted for that particular technical knowledge which is required in the test-room of a modern electrical engineering works. The reader must, however, not be a beginner; on the contrary, he must be familiar with the scientific side of electrical engineering generally, so that all he needs is a kind of finishing-touch in his technical education which will make his work in a particular direction more efficient.

In the book under review this finishing-touch is given in the matter of testing alternating-current machinery and apparatus. In all there are 127 tests described. In each case the description begins with references to the literature on the subject; then is stated the object of the test, and after that comes a short dissertation on "theory and method." In some cases the authors add suggestions as to the collection of data, the plotting of curves, the extension of the test to somewhat different cases, and questions as to the effect of varying some of the conditions of the standard test. All this is extremely useful to the advanced student, but only to him. A beginner could only blindly follow instructions, and could not grasp the true scientific meaning of the thing he is doing.

It is perhaps natural that in a book written, in the first instance, for the students of an American university, methods and tests devised by American engineers should receive more attention than equally good work done in Europe; but when the authors christen old and well-known methods by American names, they go a little further in the direction of local patriotism than is warranted. As an instance, I take the Joubert method of taking the E.M.F. and current curves of an alternator. After describing the original method (by the way, the authors spell the name Jobert), where a ballistic galvanometer is used, they describe a "Bedell method" and a "Mershon method." Both these are nothing else than the Joubert method as it has been used for a generation in Europe. In the former, the ballistic galvanometer is replaced by a condenser and electrostatic voltmeter, and in the other by the well-known device of a potential slide and D.C. voltmeter.

Again, some methods which originated in Europe are either ignored or mentioned without reference to the inventor. Thus the well-known Sumpner method of testing transformer efficiency under full load whilst only the lost power need be supplied from outside, is given without Dr. Sumpner's name being mentioned. These are, however, minor blemishes; the important thing is that the authors have given us a valuable collection of accurate tests which can be carried out with such apparatus as may reasonably be supposed to be available in the test-room of a modern electrical engineering works.

GISBERT KAPP.

EDIBLE FATS.

Edible Fats and Oils: their Composition, Manufacture, and Analysis. By W. H. Simmons and C. A. Mitchell. Pp. viii+150. (London: Scott, Greenwood and Son, 1911.) Price 7*s*. 6*d*. net.

FAT enters into human food in a considerable variety of forms, and the modern tendency is to increase the variety. Whilst in earlier days the animal products—butter, lard, and dripping—were the principal fats consumed as foodstuffs, in recent times a large number of vegetable oils and fats have also been brought into use for the same purpose. New oils and "butters" have been found; improved processes of purification have been introduced; and the industry has become one of notable magnitude. It has greatly augmented, and therefore cheapened, the supply of fat available for human consumption.

What the authors have done in the volume before us is to collect from various sources particulars of the edible fats and oils now in use, and arrange them in a convenient form for reference. These particulars include short descriptions of the origin, manufacture, physical and chemical characters, and methods for the analysis of the various products dealt with, which fall into the four main classes: butter, lard, butter-substitutes, and salad-oils. From the scope of the book, however, the descriptions are necessarily often meagre. They would serve well as an introduction to the subject, or for easy routine work in examining the various articles, but would require to be supplemented in the more difficult cases which are met with in practice.

A somewhat curious analogy is recalled by the name of Mège-Mouries, mentioned in connection with the origin of butter-substitutes. The production of beet sugar, which has now reached very large dimensions, is said to owe its early development to the encouragement given it by Napoleon I. in his policy of making France independent of foreign supplies. Now, just as this variety of sugar has supplemented and partly ousted cane sugar, so margarine has supplemented and partly supplanted butter; and the introduction of margarine we owe to investigations fostered by Napoleon III.

M. Mège-Mouries was commissioned by this monarch to find, if he could, a cheap but wholesome substitute for butter, to be used by the French poor. He eventually succeeded in doing this, utilising the softer portions of beef suet for the purpose. Later, owing to scarcity of this ingredient, it became necessary to include a proportion of vegetable oils, and this has led to a greatly extended consumption of such oils. The margarine industry is now quite a considerable one, the annual importations into this country alone being valued at more than two millions sterling.

If we consider the effect which the production of beet sugar and of margarine has had, first in augmenting the supply of foodstuffs for the human race in general, and secondly in benefiting the agriculture of the particular countries engaged in the production; and if we further remember that this effect, so far as can be foreseen, is destined to continue, from year to year and generation to generation, is it altogether paradoxical to suggest that the two Napoleons' claims to remembrance might justly be based less upon their military operations than upon their vicarious attentions to sugar and margarine? If the swords have not been beaten into ploughshares, they have perhaps been beaten by them.

C. S.

ELEMENTARY PHYSICS.

(1) *An Elementary Text-book of Physics.* Part i., General Physics. By Dr. R. Wallace Stewart. Pp. v+414. (London: C. Griffin and Co., Ltd., 1910.) Price 4*s*. 6*d*. net.

(2) *Magnetismo e Elettricità.* Principi ed Applicazioni Esposti Elementarmente da Francesco Grassi. Quarta edizione. Pp. xxiii+878. (Milano: Ulrico Hoepli, 1911.) Price 7.50 lire.

(3) *Intermediate Physics.* Prepared in accordance with the new regulations of Indian Universities. By Prof. P. L. Narasu. Pp. xii+637. (Madras: Srinivasa Varadachari and Co., 1911.)

(4) *Elementary Light: Theoretical and Practical.* By W. H. Topham. Pp. vii+212. (London: Edward Arnold, n.d.) Price 2*s*. 6*d*.

(5) *Practical Physics: an Elementary Course for Schools.* By J. Talbot. Pp. viii+112. (London: Edward Arnold, n.d.) Price 2*s*.

(6) *A College Text-book of Physics.* By Prof. A. L. Kimball. Pp. ix+692. (New York: Henry Holt and Co., 1911.) Price $2.75.

(7) *Die Elektrizität.* By Prof. F. Adami. Erster Teil. Pp. 127. Bücher der Naturwissenschaft, herausgegeben von Prof. S. Günther. 9. Band. (Leipzig: Philipp Reclam, junr., n.d.) Price 40 pfennig.

(1) THIS volume is presented as part i. of the series by the late Dr. Stewart, although the volumes on sound, light, and heat have already appeared, and publication occurs subsequently to the unfortunate death of the author. It may be said at once that as regards mode of treatment, type, and diagrams, this part is uniform with those which have preceded it, and deserves the same praise as has been given to them. There are one or two points, however, which call for criticism, and the first is with reference to the title. Actually, the contents are chiefly concerned with what is usually termed mechanics, and only a comparatively small portion is devoted to the ordinary physical properties of matter. Strictly speaking, of course, mechanics is a section of physics, and its inclusion, especially if treated experimentally rather than mathematically, is desirable in every elementary physical text-book. It is unfortunate, however, when, as in this case, such inclusion has secured the exclusion of several essentially physical properties of matter and the inadequate treatment of many others. Thus we find, for example, the viscosity of liquids only briefly referred to, and no mention at all of the same property in gases. The second criticism is in connection with two definitions in the mechanics which are vague and even misleading. In common with so many other text-books on this subject, this book lacks the fundamental definition of "mass." The author introduces the term "mass" without definition in order to define force, and then uses this definition for the purpose of defining mass. Few writers on mechanics appear to realise that a definition of mass *apart from force* is the essential first step from the point of view of absolute measurement. The other definition to which exception may be taken is that of simple harmonic motion in terms of the uniform motion in a circle of a second particle. The effect of this is to suggest to students that this second particle *really exists* in all cases of simple harmonic motion.

(2) The fourth edition of this book has been produced in order to include the numerous and important advances in this subject which have been made since 1902, particularly those which have practical applications. The subject is treated in considerable detail, but essentially from a non-mathematical point of view, and it should be possible for a novice to obtain considerable insight into the fundamental principles of magnetism and electricity, and the many useful devices depending upon them. The earlier chapters are devoted to the usual descriptions of phenomena and statements of laws in electrostatics, magnetism, and current electricity, but, owing to the absence of mathematics, exact treatment is impossible, and the absolute units of potential, current, &c., are not defined. Although the obvious intention of the author is to lead up to what is practically electrical engineering, some space is devoted to descriptions of radio-active phenomena and the electronic theory of conduction through gases. The final chapters on telegraphy and telephony—both wireless and otherwise—and the applications of electricity to traction are the most detailed in the book. Good diagrams are given, but some of the photographic reproductions leave much to be desired.

(3) Whatever may be said of the merits of this book in other respects, there can be no two opinions concerning its chief failings. These are the obvious carelessness both in correcting the proofs and in producing the very numerous diagrams. Upon opening the book we are met at once by two pages of *errata*, containing some sixty or seventy corrections to the text. That these are, nevertheless, incomplete is indicated by a rather amusing mistake on p. 30, where we are told that "the direction of gravity is shown by the 'plum-bline.'" It may also be mentioned that the diagram illustrating this instrument is a typically poor one. Many of the figures, besides being badly printed, follow the old style of depicting hands, or even complete persons, performing certain experiments. The book is specially designed to meet the requirements of students preparing for the intermediate examinations of the various Indian universities, but the author claims that it is suitable for the initial stage of any college course. For some reason it is not divided into chapters, nor even into distinct sections dealing with the various parts of the subject—an arrangement which may tend to confuse the student. With regard to the subject-matter, here again we find the same vagueness in defining "mass" as has been mentioned above in the criticism of Dr. Stewart's book. This inexactness occurs in several other places, notably in the following statement:—

"The absolute unit of potential is too large. Hence $\frac{1}{300}$ of the electrostatic absolute unit of potential *is taken* as the practical unit of potential and is termed a volt."

A similar erroneous description of the "coulomb" is also given.

(4) The author has prepared a book comprising the

theory and laboratory work suitable for various examinations of the standard of London matriculation. The general arrangement of the work is very neat and methodical, descriptions of the experiments in connection with the theory being appended to each chapter. There are also numerous examples collected, principally from papers set in the London matriculation. The author has adopted the "ray" method, since he regards it as easier to understand than the "wave" method; but he is careful to proceed in such a manner as to admit of the development of the wave theory at a later stage without apparent contradiction, and, in the final chapter, introduces the student to the elements of this theory. To those who need the information it supplies this book may be in all respects thoroughly recommended.

(5) This consists of a series of simple experiments in heat, light, electricity, and sound. The procedure is to give the boy exact instructions of what to do, and to tell him to observe and record his results. Occasional questions bearing on the experiments are also asked. This method is certainly preferable to that which is sometimes adopted, viz. to allow the student to invent his own experiments. As the author points out, the ordinary schoolboy is usually incapable of originality in a subject which is new to him, and should at first, at any rate, follow instructions implicitly. In schools this collection of experiments should be found useful.

(6) The leading feature of this text-book is the extraordinary amount of ground covered in relation to the size of the volume. Attention is devoted to all the usual branches of physics, and many details are found which seldom occur in elementary treatises; indeed, from a purely descriptive point of view the work should suffice, not merely for preparation for intermediate, but also for final examinations. This condensation of material has been made possible, however, only at the expense of that mathematical treatment which is essential for both examinations. That this is no oversight is clearly indicated by the author's preface, in which it is asserted that mathematical reasoning, even of a simple sort, is found a stumbling-block by many students. This may be true, but we cannot agree that it forms a justification for overlooking the fact that an exact knowledge of physics is impossible without frequent recourse to mathematical processes. From the author's point of view, however, consistency demands that no unproved formulæ should be quoted, but this is by no means the case. The result of this avoidance of exact treatment has been to render the book very unequal, the descriptive portions being distinctly adequate and good, but the equally essential mathematics is looked for in vain. In fact, the contents may be described as insufficient for the serious student, and at the same time much too detailed to be useful as a popular treatment of the subject. The type and diagrams are good, and the more important statements are either in heavy type or in italics.

(7) There is no subject in which there is a greater demand for books on popular lines than electricity. This pamphlet forms the first part of such a book, and is devoted to electrostatics and magnetism.

OUR BOOK SHELF.

Geologischer Führer durch das Mainzer Tertiärbecken. By Dr. C. Mordziol. I. Teil, Allgemeine Übersicht und Exkursionsführer in die Umgebung von Mainz und Wiesbaden. Pp. xii+168, with 39 figures in the text. (Berlin: Gebrüder Borntraeger, 1911.) Price 5.60 marks.

In view of the increasing interest taken in Germany in field geology, it is to be regretted that this small guide to a very accessible district should be issued at so high a price. Schubert's Dalmatia in the same series is, in fact, slightly cheaper, and students at Bonn, Giessen, and Heidelberg may feel that they have a right to more liberal treatment. Dr. Mordziol, of Aachen, indicates at the outset the limits of the basin of Mainz, a region of subsidence, in which the youngest deposits lie in the centre, while the older Cainozoic strata appear upon the margins. The gravels laid down by the Rhine in glacial times actually lie below the present level of the sea (p. 2). On the south, the basin merges into the sunken valley-floor of the upper Rhine, as is apparent on any orographic map of southern Germany.

The hilly ground bordering on the basin includes a great variety of rocks, and the problem of the gneisses on the south side of the Taunus, which may be of Devonian age, is regarded as still undecided. The true interest of the basin itself lies in its Cainozoic strata. The author (p. 15) supports Sandberger's division of Oligocene from Miocene at the base of the Cerithium limestones, in opposition to Dollfus and Steuer, who include this limestone and the whole brackish water series above it as Miocene. These strata are clearly described and illustrated, and the terrestrial sands and gravels (p. 65), derived from the decay of earlier Cainozoic and still older rocks, are held to be of Lower Pliocene age. We may remember that the Deinotherium beds of Eppelsheim, north-west of Worms, containing Mastodon, Machairodus, and Hipparion, are included in this interesting area.

The author, in tracing characteristic siliceous pebbles onward from the Hipparion-sands into Holland, makes out a case for the existence of a preglacial northward-flowing Rhine (p. 68). He then proceeds to illustrate the basin by a series of excursions, in which the underlying Permian strata are not overlooked. An index of places is much needed, but will probably accompany the second part.

G. A. J. C.

Evolution. By Prof. Patrick Geddes and Prof. J. Arthur Thomson. Pp. 248. (Home University Library of Modern Knowledge.) (London: Williams and Norgate, n.d.) Price 1s. net.

Profs. Geddes and J. Arthur Thomson have added yet another to the large number of books already existing which are designed to deal with evolution in a manner suited to the needs both of the beginner in serious study and of the general reader. The reputation of the authors will have led us to expect at least accuracy in the statement of facts, and this anticipation is certainly fulfilled in the little volume before us. Apart from the region of fact, we seem to discern a twofold influence at work, leading, on one hand, to a caution in interpretation so extreme as sometimes, we fear, to confuse the inquirer; and admitting, on the other, a boldness of speculation which is somewhat likely to disconcert him.

As an example of the former tendency may be mentioned the authors' manner of dealing with the crucial question of the inheritance of somatic modifications. No uncertain sound should be given on a point like this, but it is doubtful whether the student with only the present book before him would be as much impressed as he ought to be with the importance of the issue. The use of the word "saturating" (p. 197) does not make for clearness. The working of the second tendency is to be seen chiefly in those parts of the book which deal with social analogies and applications. These appear to us, although interesting and unconventional, to be somewhat far-fetched. But the book is a good one, and will make a strong appeal to the thoughtful. F. A. D.

The Evolution of Kingston-upon-Hull, as shown by its Plans. By Thomas Sheppard. Pp. 203. (Hull: A. Brown and Sons, Ltd., 1911.) Price 3s. 6d. net.

WHEN this island first became the home of man the site of the city of Kingston-upon-Hull bore an aspect very different from that which it assumes at present. The North Sea washed a long line of cliffs extending from Hessle to Bridlington, and the Humber, even then a mighty river, ran straight out to sea. Then followed the great Ice age, which left behind it masses of glacial drift, the foundation of the present city. The milder climate which succeeded produced abundant vegetation, which gave rise to the bed of peat which covered the site. A single bronze axe found in it was probably dropped by some visitor from a canoe, and supplies the only record of prehistoric man. Then the water encroached on the land and laid down great deposits of silt along the present valley. The Romans do not appear to have occupied the place, and the first attempt tc embank it is attributed to the Danes, who have left marks of their occupation in the plan of the older parts of the city. In time the place gained increased importance by the absorption of the adjoining villages, and in the fourteenth century the site was surrounded by a wall, of which, and of the old manor and palace of the King, whence the name of the city was derived, only a few stones remain. The later development of the city can be traced in the fine series of reproductions of old maps and drawings which illustrate this useful contribution to local history.

Proceedings of the American Society for Psychical Research. Vol. v., part i., April: A Case of Hysteria. By Dr. W. H. Hamilton, Dr. J. S. Smyth, Dr. Louis Millard, and James H. Hyslop. Pp. 672. (New York: The Society, 1911.) Price 6 dollars.

Is it worth while? Here is a tome of 660 pages devoted to the investigation of an apparently healthy young woman, Miss Burton (pseudonym), aged twenty-two, who is supposed to be able to pass into a trance-like state at will in order to become a "medium" in communication with the spirit world. There are the usual stories of raps, touchings, whistling, singing, combined whistling and singing, whispering, tambourine-playing, table levitation, &c., all by the spirits. The investigations show that the whole thing is trickery; but the investigators concede that this young damsel was perfectly honest so far as her phenomenal consciousness is concerned, but that her subconscious self was deceitful.

A Revised Catalogue of the Indigenous Flowering Plants and Ferns of Ceylon. By Dr. J. C. Willis. (Peradeniya Manuals of Botany, Entomology, Agriculture, and Horticulture, No. 2.) Pp. 188. (Colombo: H. C. Cottle, Government Printer, 1911.)

A CATALOGUE of Ceylon plants was prepared by Dr. Trimen, and published in the Journal of the Ceylon Branch of the Royal Asiatic Society in 1885; this has long been out of print; hence the necessity for the new catalogue now issued by Dr. Willis. The book is divided into two sections, enumerating respectively native and introduced plants; the latter section includes nearly all the valuable economic pants. The catalogue supplies Sinhalese and Tamil names, also references to the pages in Trimen's "Flora of Ceylon," where descriptions of the species can be found. It is noticeable that very few new species have been discovered recently. The total numbers amount to 1095 genera and 3074 species in the first section, and in the second to 285 genera and 387 species. About twenty genera and very many species are endemic.

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.*]

The Scientific Misappropriation of Popular Terms.

IN his interesting address to the Conference of Delegates at the Portsmouth meeting of the British Association, as reported in NATURE of October 19, Prof. J. W. Gregory makes certain remarks to which I venture to take exception. I comment on them partly because they push the principle of priority further than it need be pushed, and partly because I am afraid that Prof. Gregory's advice "to admit that the spider is an insect" may be taken to heart by some of his audience at Portsmouth or by some of his readers in NATURE.

Zoologists will not be surprised to learn that the word "insect" formerly had a wider application than at present. Many of them will feel that Messrs. J. H. and A. B. Comstock are not fairly treated by being taken to task for telling their readers, in a general manual, that a spider is not an insect. So far as the account of the use of the word "insect" is intended to be a historical account of the subject, and no more, criticism is unnecessary. But if it is a serious attempt to reinstate "insect" in its former meaning, I think it should be resisted on the ground that this procedure would introduce confusion where everything is at present clear, and that it has no compensating advantages to recommend it.

We are, fortunately, not obliged to apply the rules of priority to zoological names of higher value than genera. There is no compulsion to substitute Insecta for Arthropoda on nomenclatorial grounds; and it cannot be disputed that to do so would be productive of endless confusion. I am prepared to follow Prof. Gregory in thinking that it may be inconvenient to employ a familiar popular term in an altered signification in scientific writings. But in the present instance the wider use of "insect" has been so long abandoned in literature that even in popular works the majority of authors understand "insect" exactly as it is understood by a zoologist.

For one reason or another it is not unusual for a word in popular use to change its meaning during the gradual evolution of a language. It would be simply pedantic, in many of these cases, to attempt to go back to what is supposed to be the original meaning. Would Prof. Gregory recommend us to use the last word in "mice and rats, and such small deer," in its earlier signification in preference to the meaning it has acquired in modern times?

Prof. D'Arcy Thompson has put zoologists under a deep debt of gratitude by the recent publication of his translation of the "Historia Animalium" of Aristotle. Those of us to whom the original has hitherto been practically a sealed book may learn from this translation that Aristotle, in a professedly zoological work, used *γένος* in practically the sense in which we use "class." I will conclude by asking whether the principles of priority are to be held to give any countenance to the substitution of "genus" for "class" in systematic zoology.

SIDNEY F. HARMER.

58 Albemarle Road, Beckenham, October 21.

Iron Bort.

WE have been getting occasional pieces of a curious material from the diamond mines, which may prove to have a relation to the mineral described in NATURE of September 7 (J. R. Sutton, "A New Mineral?"), and also may throw some light ultimately upon the origin of the diamond. To outside appearance, in extreme cases, the material has a cindery look; in less extreme cases its diamond affinities are fairly evident. It can be readily disintegrated with a mineralogical file, but it has hard corners which will scratch corundum. The specific gravity is 3·3 to 3·5, *i.e.* slightly lighter than diamond. It is insoluble in acid, is feebly magnetic, and when suspended by a light thread or floated on water (on a cork) shows distinct polarity under the influence of an ordinary large steel horse-shoe magnet. When it is crushed a small bar magnet will readily take up small specks of it. (The mineral previously described in NATURE, by the way, shows no polarity.)

Some months ago I casually examined some pieces of this material, and concluded that they were diamond (bort) with enclosed impurities. Some of the impurity is now proved to be iron, which shows that the statement sometimes made that diamond is not found in association with iron is not quite correct.

Some pieces of this material which had been extracted by the electromagnets at the pulsator were brought in by Mr. Stewart (the manager of the pulsator) a few days ago. They were very unlike the stuff readily recognisable as diamond, but the chain of gradation from these to something more nearly approaching true bort is fairly complete. Whether a diamond buyer would put the same commercial value upon them as he would upon bort is quite another question. Up to the present time I have not come upon any true bort which shows the same magnetic properties. Like true bort, however, this material is a good conductor of electricity.

As a distinctive name for this variety of bort, or iron bort—if bort it may strictly be called—Stewartite would be suitable.

J. R. SUTTON.

Kimberley, September 30.

A Starling's Deception.

THREE weeks ago, or, to be quite correct, on September 22, I was considerably startled and surprised, on going into the garden at 9.30 a.m., at hearing what I thought was a wryneck's call in a tree not many yards off. I listened, and in a few minutes the cry came again clear and distinct as one hears it in the spring and early summer. I was astonished, knowing it to be a rare thing to hear the wryneck after the middle of July. I approached the tree (in which two or three starlings were chattering and whistling) and tried to get a sight of the supposed wryneck, but did not, although the call was repeated several times. I put down my failure to the thickness of the foliage and the ivy-grown trunk, somewhere in the midst of which the bird was doubtless in hiding.

Well, the next morning, and on several days following, the unseasonable, but otherwise very pleasant, note continued to be heard, and always from the same tree and, apparently, in association with the starlings, for I noticed that the cry invariably came after one of the starlings had whistled. The whistle, in fact, seemed to be the signal for the wryneck to sing.

It struck me as being altogether very curious, and I determined to find out, if possible, more about it. So one morning (September 27) I resolved to investigate the matter more closely. Standing under the tree, and after a little patient waiting, I got a starling well into view and watched him carefully. Wagging his head from side to side he chattered and cackled for all he was worth; then came the whistle, and immediately afterwards the wryneck's note, in uttering which I quite distinctly saw the quick movement of the beak. And so the mystery was solved! I waited, hoping to see a repetition of the performance, but the bird, I fancy, caught sight of me and flew away. On two or three of the following days I tried to catch him in the act again, but was not successful. In the early days of October the cry was not heard (at any rate by myself), but it fell on my ear once more, and for the last time, on October 6, and from the same tree.

Starlings are great mimics, I believe, and I am wondering if this particular bird has been reared in the immediate vicinity of a wryneck's nest, and so caught the note from the parent wryneck. However this may be, I thought the incident would interest your readers, and perhaps elicit additional facts of a similar nature from some of them.

I may add that in 1901, from August 19 to September 10, a friend and myself heard almost daily what we firmly believed to be a wryneck's cry. It surprised us, certainly, but, other than being very interested in hearing the unseasonable note, we never investigated the matter properly. The question now arises, were we and the neighbours deceived by a starling in 1901 as I was so nearly deceived by one this autumn?

BASIL T. ROWSWELL.

"Les Blanches," St. Martin's, Guernsey, October 18.

Hot Days in 1911.

MR. MACDOWALL'S dot diagram in NATURE of October 12 certainly shows high correlation between the number of hot days in a quinquennium and the difference between this and the number of hot days in the next quinquennium, and Mr. Corless in NATURE of October 19 finds the value of the correlation coefficient to be $-0·725$; but the conclusion is not that the number in one quinquennium is correlated with the number in the next.

If x_1 is the departure from mean value of the number of hot days in one five-year period, and x_2 that in the next succeeding, then, if these are wholly independent variables, sum $x_1x_2=0$, the minus values neutralising the plus, and the coefficient of correlation between x_1 and x_2-x_1, which is

$$\text{sum}\, x_1(x_2-x_1)/\sqrt{\text{sum}\, x_1^2} \times \sqrt{\text{sum}\, (x_2-x_1)^2},$$

becomes

$$-\text{sum}\, x_1^2/\sqrt{\text{sum}\, x_1^2} \times \sqrt{\text{sum}\, (x_2^2+x_1^2)},$$

or $-1/\sqrt{2}$, since sum $x_2^2=$ sum x_1^2 in a long series.

The value $-1/\sqrt{2}$, or $-0·707$, is within the limits $-0·725 \pm 0·059$ given, and the conclusion is that the correlation between successive quinquennia is nil.

This conclusion, based on the figures of Mr. Corless, must render ineffectual Mr. MacDowall's endeavours to make long-range forecasts of weather by correlations at five years' distance, and will disappoint any hopes that the new method may have raised in the minds of "official meteorologists."

H. E. SOPER.

University College, London, October 23.

MR. MACDOWALL, in dealing with the number of "hot" days in a year (NATURE, October 12, p. 485), compares two series of numbers which are not independent, and uses the comparison in an attempt to make seasonal forecasts. His method does not appear to be statistically legitimate. He obtains a series of numbers $N+n_3$, $N+n_4$, . . . $N+n_{m-3}$, representing the total number of "hot" days for periods of five years, 1, 2, 3, 4, 5; 2, 3, 4, 5, 6, &c., and plots a diagram showing the relation between $N+n_r$ and $n_{r+5}-n_r$, N being the mean of the five-year totals. If the scales of ordinates and abscissæ were the same, and the series of numbers $N+n_3$, &c., represented a random selection, we should expect to find in the diagram a number of dots distributed more or less symmetrically about a line bisecting externally the angle between the axes. This is what Mr. MacDowall obtains in his diagram on p. 485, allowance being made for his difference of scale. The diagram, as it stands, cannot therefore help the forecaster.

We should expect also to find a large correlation coefficient between $N+n$ and $n_{r+5}-n_r$. For a long series of numbers in which there was *no correlation* between $N+n_r$ and $N+n_{+5}$ the value of the coefficient between $N+n_r$, $n_{r+5}-n_r$ would be $-\frac{1}{2}\sqrt{2}$, or $-0·71$, say. Mr. Corless finds from Mr. MacDowall's figures a value $-0·73$. Clearly, therefore, this cannot be taken to prove periodicity.

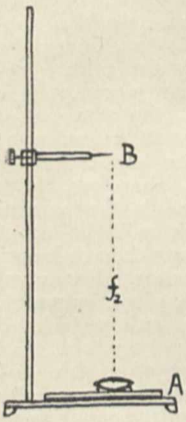
The total number of "hot" days in the nine years preceding 1911 is, according to Mr. MacDowall, 586, compared with an average of $9 \times 77=693$, so that unless there is a variation of very long period or a secular change we must in the next few years experience a preponderance of summers with more than the average number of "hot" days. E. GOLD.

Hampstead Garden Suburb, N.W., October 23.

Determination of Refractive Index of a Liquid.

THE following simple method of finding the refractive index of a liquid available in small quantities may be of interest.

A plane mirror A is placed on the base of the stand, and on it is put the double convex lens in such a position that its centre is beneath the needle point B. With the eye directly above B, the observer adjusts the sliding arm until the needle point and its image just coincide, as found by parallax. The distance from B to the centre of the lens is then accurately found—let it be f_1. The experiment is then repeated, after first placing a drop of the liquid upon the mirror, when it will be spread out to a plano-convex lens between the glass lens and the mirror—let the new focal distance be f_2; then evidently the focal length f of the liquid lens will be given by $1/f = 1/f_2 - 1/f_1$.



But since the focal length of the liquid lens is also given by the relation $1/f = (\mu - 1)/r$, where r is the radius of curvature of the surface of the glass lens, it is evident that from a knowledge of r the index of refraction of the liquid can be at once found.

If r is not known it can be found by putting a sheet of paper between the lens and mirror, and again obtaining an image of B coincident with itself by reflection in the lower surface of the lens. If this new distance from the lens be called d, we have, since reflection is now only at the upper surface of the lens, $\mu/r - 1/d = (\mu - 1)/-r$, or $r = (2\mu - 1)d$, where μ now, of course, refers to the glass, and can, if necessary, be calculated.

The apparatus is thus complete in itself, and three readings of the position of B give all the data required.

G. N. PINGRIFF.

Market Bosworth Grammar School.

The Nematodes of the Thames.

IN a recent letter to NATURE on the "Ooze of the Thames," I alluded to the number of nematodes which I had observed. I found as I continued my researches at least three different species were present. I have since been working on some ooze from near the Tower Bridge, and again find three different species, some of which are quite distinct from the forms taken at Kew. Thus the two localities yield at least four, if not five, different kinds. They range from about 3 mm. to 20 mm. or more in length. Considering the important part which some of these lowly creatures play in human and animal pathology, it would seem that the Thames mud offers a wide field for investigation. May we hope that this note will direct the attention of London naturalists to a subject of great importance lying close to hand?

Swadlincote. HILDERIC FRIEND.

Miniature Rainbows.

WITH reference to the recent correspondence on miniature rainbows, there is, or was, a most perfect example at the beautiful waterfall known as "Stock Gill Force," situate half a mile outside the little town of Ambleside, near the head of Lake Windermere, County Westmorland.

About five o'clock in the evening is the best time to see it, and, of course, the sun must be shining.

RICHD. COULSON.

4 Waltham Terrace, Blackrock, Co. Dublin,
October 15.

Olive Trees.

IN this part of the world when an olive plantation is being made trees of more than 6 inches in diameter in the stem are put in, with all roots cut off short. In the hole where they are planted about two handfuls of barley are also put in.

Considering the age of the trees and the way the roots are cut away, it would seem impossible that the tree would ever grow.

These facts may be of interest; and I should like to know what useful purpose is served by the barley.

Smyrna, Asia Minor. DORA BARFIELD.

EXPLOSIVES ON BOARD BATTLESHIPS.

SOME people have been tempted of late to look back to the old days when black powder held its sway, indifferent to the effects of temperature, and always to be trusted so long as it was kept dry. "Villainous saltpetre" it was called, with a rough affection, and after storing it on shore in magazines plumed with lightning conductors, or comfortably near the boilers on board ship, we never gave it a thought until it was fed, in its flannel bag, into the gun. Then came armour and the long and hard contested duel between protection and penetration. The velocity of the projectile had to be increased. The old black powder, treat it as we would, could only deliver its rather clumsy blow which, while it imparted but a low velocity to the shell, gave an unpleasant, percussive strain to the gun. It was a push that these heavier projectiles required, not a blow.

This state of things led to the introduction of slow-burning powders, and they progressed very slowly. First, the size of grain of black powder was increased until it attained the dimensions of a two-inch cube. The improvement, however, was slight, and the internal stresses on the bore of the gun were still too great. The next step towards real progress was the introduction of what was known as cocoa, or brown powder, in which materials other than dogwood or alder furnished the carbon. This had but a short reign, its place being taken by various propellants which were frankly chemical compounds. To give a list of all this class of propellant, with which experiments and lengthy trials have been carried out with more or less success, would be far beyond the scope of this article; but the interest of the scientific world gradually focussed itself on compounds having nitro-cellulose as their chief constituent, especially after the wonderful discovery that two high explosives, gun-cotton and nitroglycerine, when chemically compounded, tamed and restrained each other, so that a propellant resulted of which the speed of burning could be regulated at will by increasing or diminishing the size of the grain or cord, and also by adjusting the proportions of its constituents. Thus came to man's hand a propellant which far outstripped black powder even in its improved forms, and threw into shade the cocoa powder which, after all, remained in the category to which the French artillerists contemptuously alluded as *poudre brutale*.

"Now," triumphantly exclaimed the gunmakers, "here is a propellant which will enable us to increase the striking velocity of our armour-piercing projectiles, and also to flatten our trajectories to an extent never before contemplated. The cemented steel plates will no longer confer invulnerability on the battleship, and our chances of hitting her will be vastly enhanced." So, to suit the new powders, guns were lengthened and charges increased, and the muzzle velocities rose by leaps and bounds, while the destructive stresses on chamber and bore were minimised by the employment of a propellant the characteristics of which may be summed up in the one word "suitable." Every nation adopted a powder in which nitrocellulose played the leading part, the variants being the proportions of nitroglycerine and the quantities and qualities of additional restrainers.

For a time all went well; but we, as a nation, were pointed at as being behind the times because our cordite, since it contained rather a large proportion of nitroglycerine, developed more heat, and produced more bore-erosion than powders of what had become practically pure nitrocellulose. But soon a cloud, no bigger than a man's hand, appeared above the horizon, and it was found that this class of propellant exhibited an almost sentient dislike to extremes of temperature. Not being a mechanical mixture, like the old black powder, it proclaimed itself a chemical compound with a marked tendency to instability, in a somewhat disconcerting manner. Great heat disorganised it altogether; extreme cold brought the nitroglycerine, if there were any used in the manufacture, to the surface, and this did not add to the gunner's confidence in it. The tendency to deterioration from exposure to undue heat, however, was seen to be the more to be feared of the two, and it was a drawback with which it was exceedingly difficult to deal. So far as cordite was concerned, it was found to remain stable at temperatures under 80° Fahr., but in some of the older ships, owing to steam pipes being led near, and even in some cases through, the magazines, temperatures as high as 140° were recorded, and these were equalled by those in limber boxes in some stations in India.

To keep a check on this deterioration the heat test, invented by the late Sir Frederick Abel, has always been used in this country and in the Colonies, and to its frequent application is most certainly due our immunity from explosions on board battleships. One is almost tempted to write *unberufen* before stating that we are exceptional among the larger navies in having *not* lost a ship by the explosion of its own powder. We have had our warning and have profited by it. Some ten years ago a cordite cartridge ignited on board one of our battleships, but did not fire those around it. Up to 1906, when spontaneous ignition of cordite took place with what might have been disastrous results at Haiderabad and Ferozepore, cordite, with the exception of the one cartridge mentioned above, had not given rise to an accident in thirteen years. Catastrophes were averted at both these places by conspicuous acts of daring on the part of officers and men, in the first-named by drenching boxes of cordite set smouldering by one in which the cartridges had fired, and in the other by the removal of nine tons of black powder from a burning magazine within a few feet of which were stored 135 tons of black powder.

There is now little doubt that the destruction of the United States ship, the *Maine*, was due to the spontaneous explosion of her own defective powder, and also of other ships which have since been similarly lost; the Japanese have lost two, the French two (including the *Liberté*), and the Brazilians one ship. About four years ago we began to set our house in order by installing cooling apparatus in the vicinity of the magazines, by which the temperature is kept below 80° Fahr., and the ventilation system gives the charges what may be described as an atmospheric washing, as the surrounding air is being constantly cooled and changed. Great care is taken, moreover, in the construction of our ships to protect the magazines from heat given off from boilers and steam pipes. It is natural that both magazines and boilers should be placed below the water-line, and in the least vulnerable part of the ship, and that, therefore, they should find themselves fairly close together; but a good thickness of insulating material can be interposed, and the lagging of steam pipes, purposely added to ensure the retention of heat, much diminishes radiation in their vicinity. Such precautions as these serve to reduce risk of spontaneous ignition to a minimum, and they are well worth the initial cost; but alone they are insufficient, and to them must be added periodical examinations of the propellant, the heat test being then the detective.

It would appear that gelatinised nitrocellulose is liable to be attacked by an organism which rapidly brings about its deterioration, and that nitroglycerine acts to a certain extent as an antiseptic. Another theory is that the nitroglycerine hardens the substance, and renders it less susceptible to climatic influences. The net result, however, is that pure nitrocellulose is undoubtedly less stable than nitroglycerine compounds such as cordite, and that the measure of immunity of the latter from effects of extremes of temperature varies directly with the proportion of nitroglycerine. The main difficulty, therefore, with which the authorities have to contend is the natural leaning towards a propellant which will be proof against baneful climatic influences, even though it may have a greater erosive effect on the gun. For naval services these considerations have to be nicely balanced, but the preponderance must ever be on the side of safety. Guns can be changed when worn out, and their cost, when compared with that of a ship and its crew, is negligible; hence the absolute necessity for cooling apparatus, the insulation of the magazines, effective drowning arrangements, and periodical inspections of the powder.

Nitro-compounds have one great advantage over black powder—they do not explode with nearly the same violence unless very closely confined. Even when, as in the case of the Ferozepore conflagration, the cordite is confined in metal-lined cases, it only burns with great vehemence, and, with effective flooding arrangements, there should be time to prevent disastrous explosions on board ship. At Ferozepore the removal of the black powder, as described above, averted what might have been a terrible disaster. On board battleships the gases evolved by a large conflagration of any nitro-compound would be confined, more or less, by the protective steel deck, bulkheads, and watertight doors, but it is difficult to account for the terrible disruptive effects manifested in the explosion in the ill-fated *Liberté*. It is probable, however, that she had on board her full complement of high explosive (Mélinite) shells. The intense heat of burning cartridges would probably fire one of these, and this would certainly detonate those in the same shell-room. This, of course, is only conjecture, but the curious tearing of steel plates, and the projection of large pieces of heavy armour to great distances, would seem to point to something more in the nature of the detonation of a high explosive than the upheaval that would be caused by the imprisoned gases of a propellant. The inquiry into the cause of the catastrophe will no doubt throw light on this point, but its fatal consequences will tend to make all nations redouble their precautions, not only as regards the storage in battleships, but also in the direction of extreme care in the selection of a propellant which shall not only meet ordinary Service requirements, but on the stability of which they may place absolute trust.

Desmond O'Callaghan.

THE SHARMAN SYSTEM OF WIRELESS TELEPHONY AND TELEGRAPHY.

WIRELESS telephony by induction and conduction has of late years occupied an insignificant position, owing to the efforts that have been made to obtain satisfactory transmission of speech by means of undamped oscillations, such as are produced with the "singing arc." But provided that a reasonable distance can be overcome, the conduction system is one which demands serious attention on account of the small amount of power required and the simplicity of the apparatus.

The system on which Mr. A. W. Sharman has been at work for some time is based on the earlier experiments of Preece, but its essential feature is the "impulse coil," with which the microphonic currents are intensified before transmission through the conductive medium.

During the past twelve months the writer has had various opportunities of working with Mr. Sharman's apparatus, both on land and sea, and there has been ample proof of the possibilities of the system, as with a primary energy of only a few watts clear telephonic communication has been established at distances ranging between half a mile and a mile and a half.

The speaking apparatus consists of a microphone, battery, and impulse coil, all of which are in series; tappings are taken off the coil, the two wires leading to metal electrodes, which are either stuck in the ground or submerged in the water, as the case may be. The impulse coil consists of a comparatively low number of turns of thick copper wire, wound round a soft iron composite core of special construction, and the result is that with every variation in resistance of the microphone, when someone is talking, a momentary current of great intensity is induced. This is "transformed down" by the portion of the coil used for transmitting the impulse to the conductive medium, the coil thus serving additionally as an auto-transformer. The wires leading from the impulse coil may be from ten feet in length upwards; thus with two ten-foot wires there would be a possible distance of twenty feet between the extreme ends; the ends are attached to plates or rods—stair-rods proving eminently practical for placing in the earth.

The receiving circuit consists of two similar electrodes, which are placed in series with the telephone receiver. A change-over switch in the instrument enables one to speak or listen at will.

There appear to be several factors upon which the limit of clear speech transmission depends. Thus with a wider base line, *i.e.* a greater distance between the electrodes, longer distances can be covered, while with an increase in the battery power used with the microphone a similar result is obtained. There is a serious limit, of course, to increasing the primary energy, as the microphone will not admit of the use of more than eight or ten volts in practice; various forms of microphone have been tried, and those permitting of the use of the highest voltage and largest amount of current have proved the most successful.

A number of experiments have been made with the earth as the conducting medium, and distances of a mile have been covered without difficulty; the nature of the ground does not appear to be a very important factor, as good speech has been transmitted through chalk, gravel, and various other soils, also from the interior of coal mines at a depth below the surface of nearly one thousand feet; in the latter case a number of different strata separated the two instruments, without any apparent detriment to the speech.

The electrodes appear to act as the foci of an elliptical disturbance, which travels chiefly in the direction at right angles to the major axis, and not at all in the line joining the two points. It is thus desirable to have the two base lines parallel, and the necessity for this provides a means of directing the energy, so that with a flexible base line, speech will only be carried in certain desired directions, and cannot readily be "tapped" in other directions. The directional effect was very noticeable in experiments recently carried out on the sea at Pegwell Bay, near Ramsgate, even when the distance between the water "plates" was a hundred feet and more.

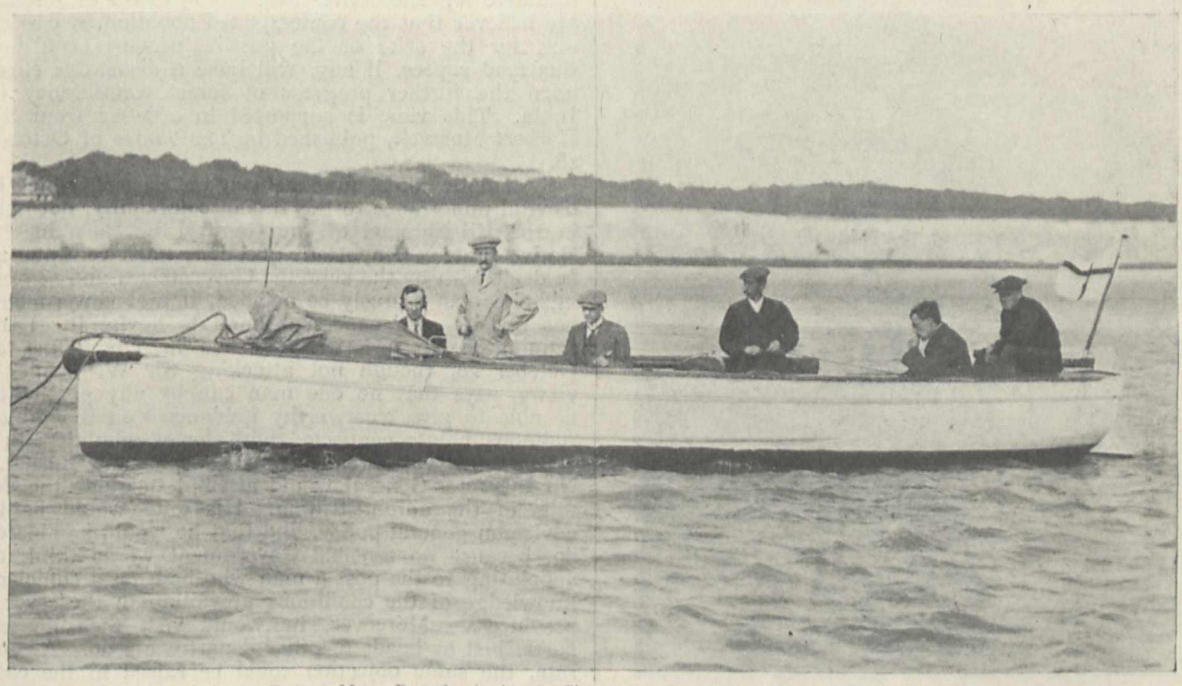


FIG. 1.—Motor Boat fitted with the Sharman Apparatus for Wireless Telephony.

A particular feature of the conduction system is that it is not superficial, as was at one time suspected. The clear telephonic conversation carried out between the low level in a mine and the surface dispelled the idea altogether, and hence no difficulty would be experienced in speaking from a battleship to a submarine, even when the latter was submerged to a very considerable depth.

In the experiments recently carried out by Mr. Sharman, a motor-boat was employed as the floating station, and two plates of iron buried in the sand led up to a shore station situated in a room in an inn on the cliff. Speech was carried on very distinctly on some occasions over a distance of a mile and a quarter, but there were some apparent variable factors, possibly water temperature, which prevented an absolute uniformity of results. An interesting point is that, when the tide was some distance out, there being half sand, half water, between the two stations, the speech was quite perfect, so that it is improbable that

FIG. 2.—The Wireless Telephone Apparatus in use.

there is any refraction of the waves at the separating surface. It is possible that the currents were transmitted through the sand right up to the position immediately under the motor-boat, selecting the shortest path through the water, for, in the writer's opinion, increase in the conductivity of the separating medium does not by any means agree with increase in the loudness of the transmitted speech.

Considering the very small amount of primary energy used, the results so far obtained have been surprisingly good, and it is to be hoped that efforts to find a microphone capable of withstanding heavier currents will meet with success. The extreme simplicity of the system and insignificant bulk of the apparatus used are in themselves points which place it at once on a level with commercial telephony over wires. A great advantage of the system is that telephony or telegraphy are available at will, as impulses can be generated by means of a Morse key and low-resistance tuned buzzer, and signals transmitted over at least double the distances at present possible for speech. There is undoubtedly the prospect of considerable development in a system based on such simple foundations, and Mr. Sharman's future work in this direction will be watched with interest.

T. THORNE BAKER.

FORESTRY IN INDIA.

IN the issue of NATURE of October 12, attention was directed to Lord Curzon's spirited protest against the change of system in regard to the preservation of the ancient monuments of India. In a letter published in *The Times* of October 11, Sir W. Schlich enters a similar protest against the proposed abolition of the post of Inspector-General of Forests, the technical adviser of the Government of India on all questions referring to the administration of the forests of India. He points out the immense progress made during the last forty-seven years in the systematic management of the forests covering one-fourth of the total area of British India, a progress chiefly due to the initiative of successive inspectors-general of forests. He believes that the contemplated abolition, if carried out, for the sake of the possible saving of a few thousand rupees, if any, will have a disastrous effect upon the further progress of forest conservancy in India. This view is supported in a letter from Sir Herbert Maxwell, published in *The Times* of October 18.

Systematic forest management on scientific lines is of vital importance to the Indian community, not only in the British part of the country, but also in the Native States. Important questions must continue to be dealt with by the supreme Government, and serious mistakes can scarcely be avoided, if that Government has not its own expert at hand to advise it. Lord Lamington, in a letter published in *The Times* of October 20, though not attacking Sir W. Schlich's views, says that no one man can by any possibility be able to give trustworthy guidance "on the multitudinous points connected with forest administration over such a vast area as that of India and Burma." No Inspector-General would attempt to guide the details of the administration. His duty would be to advise on general policy, and that he would be able to do, because no sensible Government would think of appointing to the post a man who had not a sufficient knowledge of the conditions prevailing in the several provinces. Moreover, he would visit the different parts, just as heads of other departments do. At any rate, the same objection could be raised in the case of any other branch of the administration.

Decentralisation is desirable in such a large country as India, but it must not go so far as to deprive the supreme Government of the necessary technical advice. The Government of India will still have to deal with numerous questions, such as the establishment of further reserved State forests, legislation in connection with it, the general lines on which the management of the forests is to proceed, the control of the Imperial Forest College at Dehra Dun, the Research Bureau and its labours, extending over the several provinces, advice to Native States as regards forest administration, the education of the Imperial forest staff, as well as of the superior provincial staff, the organisation and reorganisation of the superior and subordinate staff, and last, but not least, the control of forest finance. Without a duly qualified technical adviser at headquarters, these questions cannot possibly be dealt with in a satisfactory manner. No doubt, the Secretary of State for India will take all these matters into consideration when dealing with the proposals now before him.

AN ALBUM OF GEOLOGICAL TYPES.[1]

THE success of the British Association series of photographs of geological interest has encouraged the issue of several further collections. Prof. Stille, of Hanover, has arranged for the publication of a series of pictorial monographs illustrating various geological and physiographic phenomena which are confined to special regions, and of areas which especially well illustrate geological principles. The parts announced deal especially with glacial geology, mountain structures, and physiographic types, such as the Karst.

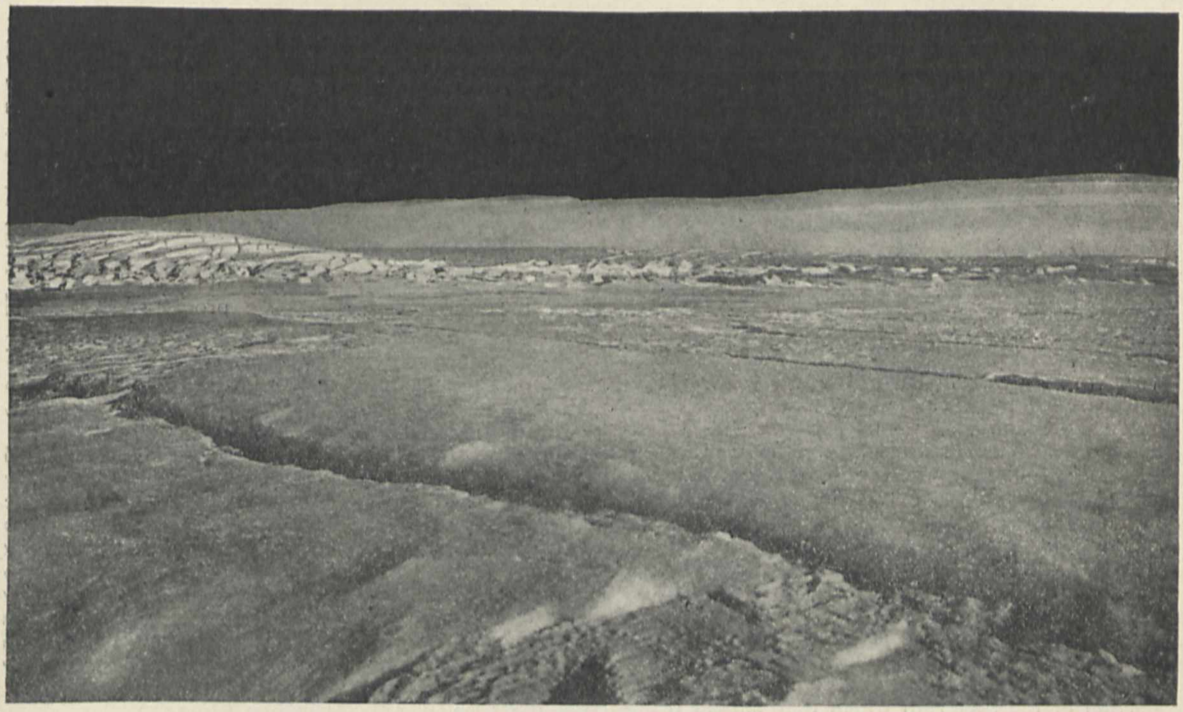


FIG. 1.—Inland Ice seen from the Gaussberg. Reduced from "Geologische Charakterbilder."

The first of this series is a collection of six plates of Antarctic icebergs and land-ice, from photographs contributed and explained by E. Philippi, the geologist of the German Antarctic Expedition. The photographs are each 8½ by 6 inches in size; they are excellently reproduced in appropriate tones of black, blue, and green.

The first photograph gives a general view of the inland-ice seen from the Gaussberg, near the headquarters of the German Antarctic Expedition. It is described as a vast ice sheet, now 300 metres thick, but in recent geological times at least 400 metres thicker. Its surface is free from moraines, but the ice contains bands of rock débris, showing that it has passed over or is resting on an uneven rocky surface.

The Antarctic floebergs are illustrated by a view of a large berg floating in Posadowsky Bay; its height varies from thirty to forty metres above the sea, and rarely exceeds fifty metres; but only one-sixth or one-seventh of the ice is above sea level. Herr Philippi refers to some of the bergs met with on the expedition as sixty miles long. The details of the composition of this berg are shown in a view of one part of its face, and its evidence is consistent with the belief in the snow-fed origin of the upper layers of these bergs. The presence of included bands of moraine material shows, however, that they have been either formed on land or have grounded at some time during their voyage.

The author contributes an interesting note on the characters of the included stones, which are described as usually angular; many have been flattened on one or more sides, like the facetted stones of some ancient glacial deposits. Stones which are ice-scratched on all sides are rare in these Antarctic icebergs.

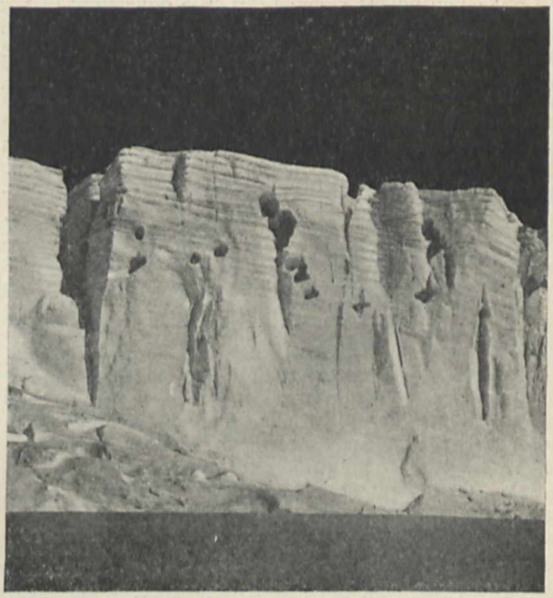


FIG. 2.—Vertical wall about 40 metres high of an Iceberg with distinct stratification planes and fissures, Posadowsky Bay, Antarctic. Reduced from "Geologische Charakterbilder."

These photographs promise to be of great value to

[1] "Geologische Charakterbilder." Herausgegeben von Prof. Dr. H. Stille. Heft i., Eisberge und Inlandeis in der Antarktis, by E. Philippi-Jena. 6 plates. (Berlin: Gebrüder Borntraeger, 1910.) Price 3.60 marks.

teachers of both geology and geography; and their value would be much greater to British students if the titles of the plates were repeated in English, for which there is abundant space on the explanatory sheets. The titles are short and necessarily technical, and their translation, unaided by context, would be often too difficult for the students to whom these photographs should be of most value. J. W. G.

THREE-COLOUR KINEMATOGRAPHY.

IN spite of the large amount of work which has been done upon three-colour photography, it is doubtful whether the results obtained by the newer methods are in any way superior to those obtainable by the original three-colour projection process used by Maxwell in his classic lecture.

In three-colour photography, three negatives are taken, one through a red, a second through a green, and a third through a blue-violet filter. Having secured the negatives, we may then proceed to produce a three-colour photograph by one of two methods: either we may prepare black positives from our negatives and project the three positives by means of the three primary colours, or we may prepare from each negative a print in some substance such as bichromated gelatine, which can be dyed in the colour complementary to the taking filter. The superposition of these three-coloured positives will then give a coloured picture. It is found, however, in practice, that the first method, which is known as the additive process, gives results appreciably superior to the second or subtractive process. The cause of this lies in the fact that the dyes used for preparing the prints cannot completely absorb the colours which they are required to absorb, and, at the same time, completely transmit that portion of the spectrum which they should transmit. While the yellow dye is fairly satisfactory in this respect, and the red dye efficiently transmits red light, the red dye always fails to transmit sufficient blue light, and the light blue dye, used for the prints from the red negative, never transmits either sufficient blue light or sufficient green light, the deficiency in the transmission of green being usually very marked, and resulting in the reproduction of all dark green objects as browns, or at best, blacks.

For the first method or additive process it is, of course, necessary to use three separate projection systems, and owing to the great loss of light through the filters these are advisedly supplied from three separate light sources. Unfortunately the unsteadiness of arcs makes it very difficult, if not impossible, to use three separate arcs, and consequently the best system is probably that arranged to use three large Nernst burners, the triple lantern being arranged so that the three projection systems stand vertically one above the other, and the three positives, printed on one plate, can be inserted together and focussed simultaneously, the adjustments for register being made once for all upon the lantern, so that subsequent slides register automatically. If an arc lamp is used, as in Mr. Ives's apparatus, only one lamp can be used, and the light from this must be divided into three by means of a system of reflectors, a procedure which unfortunately is frequently very wasteful of light and leads only to unsatisfactory results.

Attempts to apply triple projection methods to kinematography have frequently been made, but have not yet come before the public, except in the "Kinemacolor" method, which uses only two colours, abandoning the third, and so eliminating much complication. A two-colour method can, of course, at best be only a compromise, but it would seem at present to be the most satisfactory for kinematograph work.

In kinematograph work it is not necessary to project the colours to be combined simultaneously, as in the ordinary projection method. The colours can be successively projected, the observer combining them by persistence of vision. The three negatives are taken in turn on one film, a rotating shutter being arranged behind the lens of the camera carrying the three filters; but if the image is not to flicker strongly on the screen, it will be necessary for all three filters to be exposed within the ordinary period of exposure of a single kinematograph picture, which involves an exposure for each filter of about one-fiftieth of a second, a rate of work which is not only a great strain on the film and apparatus, but represents very brief exposures when it is remembered that the negatives must be taken through strongly absorbing red and green filters.

Attempts have been made to project the three images simultaneously by means of three separate optical systems, as in ordinary three-colour work, but the difficulties of register have been found very serious, although it is not at all clear why this should be so if both positive and negative sets of pictures are handled simultaneously on films of three times the normal width.

In the "Kinemacolor" method, the spectrum is divided into two, one taking-filter being orange-red and the other blue-green. In order to get a satisfactory rendering of greens, the latter taking-filter must be rather greener than a true blue-green filter would be, and in the resulting picture blue is little distinguishable from blue-green, while a yellow is rendered rather as an orange than a true yellow. The results are, however, surprisingly good considering the theoretical difficulties of the method and the extreme badness of ordinary two-colour work, and they will doubtless be even better when the promoters of the process have learned that above all things they must avoid in their pictures the two colours which they are using for projecting. These two colours are a pure red and a very bright blue-green, or minus-red colour, and in some of the pictures at present there is a tendency to use these two colours in the composition of the original scene, so that one gets little girls dressed in red blouses and blue-green skirts, which colours the process renders with only too distressing fidelity. Considering the excellent way in which the process reproduces subdued colours, such as browns, there really seems no need for this. A much less serious defect in the process, and one which is, of course, unavoidable, is that when anything moves rapidly it is projected as a series of coloured images, so that a horse's leg on the screen may appear as a series of alternately red and blue-green legs.

There is no doubt, however, that kinemacolour is a success, and is a striking testimony to the good practical results which may sometimes be obtained from a theoretically inaccurate system.

In a recent patent it has been suggested that the successive and synchronous methods of projection might be combined, two projecting systems being used with two sets of pictures, one set representing only one-colour element, such, for instance, as red, while the other is composed alternately of pictures of the other two-colour elements, blue and green. A stationary red filter is used in front of one projecting lens, while the second film is projected through a rotating filter, part green and part violet. This would appear to be somewhat more complicated than the two-colour system, while the colour rendering should undoubtedly be superior; but the method does not appear to have, at present, reached the stage of practical use.

C. E. KENNETH MEES.

PROPOSED REFORM OF THE CALENDAR.

IN the issue of NATURE for April 27 a concise account was given of the various proposals which have recently been put forward for the reform of the calendar. There is no reason to think that the subject has gained any serious general attention in England, if the fixing of Easter and the dependent festivals be regarded as a distinct question. But it has received a certain recognition in the discussions of some public bodies of an international character, such as the Congress of Chambers of Commerce; and the Swiss Government has invited a conference for its formal consideration. In order to bring a definite scheme before the public a Calendar Reform Bill was presented to Parliament by Mr. Robert Pearce. The main features of the Bill were briefly described in the article quoted. The first day of the year is called New Year Day, and is placed outside the reckoning of the week and the month. In leap years a day called Leap Day is intercalated between the end of June and the beginning of July, and is equally excluded from the week and the month. By this device there are left 364 days in every year, which are divided into four equal quarters of 91 days. Each quarter is subdivided into three months containing respectively 30, 30, and 31 days. Since 364 is exactly divisible by seven, the first of January always falls on the same day of the week, and the result of making this day Monday is to give 26 weekdays in every month, the four longer months containing five Sundays. Every calendar date corresponds to a particular day of the week (*e.g.* Christmas Day always falls on a Monday), and the calendar is fixed, no longer changing as at present from year to year.

No doubt such a system possesses slight advantages from the point of view of simplicity over our present calendar. Apart from the objections which must be urged against any disturbance of conventions to which we have grown accustomed on anything less than adequate grounds, the great disadvantage attaches to the scheme that it interrupts the continuity of the weeks. The practical effect of this is seen where two or more calendars are in use side by side. Thus inconvenience must arise even now from the Jewish Sabbath falling on our Saturday. Under the provisions of the Calendar Reform Bill the case would be worse, for it would no longer hold a fixed place in the Christian week.

A second Bill has now been presented to Parliament, this time by Sir Henry Dalziel. While differing from Mr. Pearce's Bill, the new proposals contain nothing of importance which will be novel to readers of our previous article. For the Bill merely embodies the suggestions made by Mr. John C. Robertson at the fourth International Congress of Chambers of Commerce held in London in June, 1910. The differences arise in the treatment of the four quarters of 91 days. These are divided into three months containing respectively 28, 28, and 35 days. Thus each month contains an exact number of weeks, and is made to begin with a Sunday. Incidentally it is necessary to move Easter Sunday from April 14, as before proposed, to April 15. Also Christmas Day will fall automatically on a Wednesday instead of on a Monday. The advantage of the whole scheme is to obtain commensurability between the month and the week, but it is an advantage dearly bought at the sacrifice of even approximate equality between the months. This necessitates special legal provision for payments in the case of monthly contracts to be made proportional to the length of the month concerned. Moreover, it requires legal definition for the duration of a "month" from any given date. Thus we understand that a month beginning on any day of the last week of a long month (containing 35 days) will close on the last day of the following month. At least, this is the interpretation which, after careful thought, we have placed upon the following interesting example of Parliamentary draughtsmanship :—

"8. In calculating monthly periods the following rule shall apply :—In any period beginning in a long month and ending in a short month, the last day of the short month shall be held to be the corresponding day to any of the days in the last week of the long month."

If this interpretation be correct, a month may mean any period from 28 to 35 days in length. Surely the clause comes perilously near to a *reductio ad absurdum* to the whole scheme. We can imagine the following simple problem :—"A domestic servant is engaged on March 32 at 22*l*. a year. What is the amount of the first monthly payment, and when will it fall due?" We are utterly at a loss to solve the question, and suggest it for the consideration of the framers of the Fixed Calendar Bill.

The fundamental feature common to both the Bills alluded to is the use of the *dies non*. Mr. Alexander Philip, who was responsible for reviving the idea of this fiction and advocating its practical convenience, appears to have become impressed with the extent of the opposition likely to be encountered before it can be adopted. Accordingly, in a paper before the section of Economic Science and Statistics, read at the recent meeting of the British Association, and in a pamphlet with which we have been favoured, he seems to have abandoned those who are seeking to give legislative form to his ideas, and to advance a totally different suggestion. This requires that February shall gain two days, that July and October shall each lose one day, and that the extra day in leap-year shall be placed at the end of June. Then in each quarter (now containing three calendar months) a period of twelve weeks (always beginning on a Sunday) can be found, two such successive periods being separated by a week. The idea is that public engagements can be more conveniently fixed by reference to the proposed twelve-week period, while the correspondence between this reckoning and the ordinary calendar can be very simply exhibited by a "perpetual adjustable" arrangement. But this practically means that we should have two calendars side by side, and no further criticism seems to be necessary.

It is fairly evident that the group of people who are bent on introducing a change in our present calendar are not agreed as to the precise form which that change should take. In the meantime it is probable that public opinion in this country is not ripe for any reform. It would welcome a fixed Easter, but it is more than likely that any radical alteration of the calendar would be resented. Since the reformers adhere to the yearly divisions of the Gregorian system, no scientific question is involved at any point, and the public convenience and public feeling are alone concerned with the issue. H. C. P.

NOTES.

A SOMEWHAT tardy recognition of the service rendered by Amedeo Avogadro to systematic chemistry was made by the unveiling at Turin of a bronze monument to his memory on September 24, erected, as the result of an international subscription, under the auspices of the Royal Academy of Sciences of Turin. The King of Italy presided at the inauguration ceremony, which was attended by nearly all the more eminent Italian chemists and physicists, as well as by a number of representatives of foreign academies, including M. Haller, of the Paris Academy of

Sciences; M. Moureu, of the Chemical Society of France; Prof. Nernst, of the Chemical Society of Berlin; and M. Guye, of the Geneva Society. No representative of the Royal Society or of the Chemical Society was, unfortunately, able to be present. The date selected was the centenary of the publication of Avogadro's celebrated memoir.

SIR WILLIAM E. SMITH, C.B., Superintendent of Construction Accounts and Contract Work, has been appointed to succeed Sir Philip Watts, K.C.B., F.R.S., as Director of Naval Construction. Sir William E. Smith was born in 1850, and joined the Portsmouth Dockyard in 1861, when only eleven years of age. In 1865 he was apprenticed as a shipwright at Woolwich. In 1866 he was transferred to Portsmouth Dockyard, and, having spent four years' apprenticeship, joined the South Kensington School of Naval Architecture. He entered the Royal Corps of Naval Constructors in 1873, and succeeded Sir William White as an instructor of naval architects at the Royal College at Greenwich in the early eighties. Sir William E. Smith is the Admiralty representative on the Committee of Shipbuilding Materials, in connection with engineering standards. He represents the Institution of Naval Architects, of which he is a vice-president, on the executive council of the National Physical Laboratory.

AT the annual statutory meeting of the Royal Society of Edinburgh, held on October 23, the following office-bearers were elected:—*President,* Sir William Turner, K.C.B., F.R.S.; *vice-presidents,* Prof. J. C. Ewart, F.R.S., Dr. J. Horne, F.R.S., Dr. J. Burgess, Prof. T. Hudson Beare, Prof. F. O. Bower, F.R.S., Sir Thomas R. Fraser, F.R.S.; *general secretary,* Prof. George Chrystal; *secretaries to ordinary meetings,* Dr. C. G. Knott, Dr. R. Kidston, F.R.S.; *treasurer,* Mr. J. Currie; *curator of library and museum,* Dr. J. S. Black; *councillors,* Prof. D. Noël Paton, Dr. W. S. Bruce, Prof. F. G. Baily, Dr. J. G. Bartholomew, Dr. R. H. Traquair, F.R.S., Prof. J. Walker, F.R.S., Prof. A. Robinson, Sir W. S. M'Cormick, Prof. Crum Brown, F.R.S., Prof. T. H. Bryce, Dr. Benjamin N. Peach, F.R.S., and Mr. W. A. Carter.

FOR several years past Dr. W. N. Shaw has organised for the months October to March a series of meetings at his office for the informal discussion of important contributions to meteorological literature, especially those by colonial or foreign meteorologists. When these meetings took place at the old Meteorological Office in Victoria Street their success was so great that the room available was scarcely sufficient to accommodate those who attended them. In the new quarters at South Kensington the space is nearly all that could be desired, and Dr. Shaw welcomes not only those who contribute observations to the office, but others interested in meteorology. The meetings take place on Mondays every fortnight, and the first of the series commenced last Monday. In the circular which announces the dates of the meetings a list of the suggested subjects for discussion is given, and these show the wide range which the discussions cover. The writer of this note has attended most of the meetings already held, and with others he knows that they serve a very useful purpose. The bringing together of those interested in meteorology and the friendly interchange of views is a sure way of accelerating the advance of the subject in question.

AT the conclusion of the Harveian Oration, delivered by Dr. Theodore Williams at the Royal College of Physicians on October 18, the president of the college, Sir Thomas Barlow, presented the Baly and the Bisset Hawkins gold medals. The Baly medal was awarded to Prof. W. D. Halliburton, F.R.S. This medal was instituted in 1866 "in memoriam Gulielmi Baly, M.D.," and is awarded every alternate year to the person who is deemed to have most distinguished himself in the science of physiology, especially during the two years immediately preceding the award, and is not restricted to British subjects. The Bisset Hawkins medal was given to Dr. Clement Dukes. This medal was established in 1896 by Captain E. Wilmot Williams, at the suggestion of Dr. Theodore Williams, to perpetuate the memory of Dr. Bisset Hawkins. It is bestowed triennially on some duly qualified medical practitioner who is a British subject, and has during the preceding ten years done work deserving special recognition in advancing sanitary science or in promoting public health.

A REUTER message from Stockholm states that the Nobel prize for medicine has been awarded this year to Prof. Allvar Gullstrand, of the Upsala University, for his research work in connection with the dioptrics of the eye.

THE fourth Norman Kerr lecture in connection with the Society for the Study of Inebriety will be delivered by Prof. G. Sims Woodhead on Tuesday, November 14, in the lecture theatre of the Pathological Department, Medical Schools, Cambridge, upon "The Action of Alcohol on Body Temperature and on the Heart."

AT a recent meeting of the executive committee of the British Science Guild, a committee was appointed to consider the question of holding lectures and the reading of papers. Other matters considered were the reduction of postage on scientific literature, coordination of charitable effort, and pollution of rivers. In connection with the committee on the conservation of natural sources of energy, it was decided to print the report at the end of the year.

THE members of the International Commission on Zoological Nomenclature have unanimously invited Prof. K. Kraeplin, Direktor des Naturhistorischen Museums, Steinthorwall Hamburg, Germany, to serve on the commission until the next International Congress, in the place of Prof. Maehrenthal, deceased; also Dr. P. Chalmers Mitchell, F.R.S., secretary of the Zoological Society of London, in the place of Dr. G. A. Boulenger, F.R.S., resigned.

A COURSE of twelve Swiney lectures on geology, dealing with "The Natural History of Rocks," will be delivered by Dr. T. J. Jehu in the lecture theatre of the Victoria and Albert Museum, South Kensington, during November, on Mondays, Tuesdays, and Saturdays, beginning Saturday, November 4. Admission to the lectures is free.

As the result of a personal visit to Kew, the Rev. Hilderic Friend has been able to report to the director the discovery of a considerable number of new annelids in the Royal Gardens. These include, among others, *Achaeta bohemica*, Vejd., *Dero obtusa*, D'Udek., and others new to Kew; *Paranais naidina*, Bret., and others new to Britain; and *Limnodrilus aurantiacus*, Friend, *Enchytraeus exiguus*, Fr., and *Fridericia pulchra*, Fr., new to science. The descriptions of new species will appear in *The Naturalist* and elsewhere.

FROM Prof. A. G. Nathorst, of Stockholm, we learn that Prof. Paul Richter, of Quedlinburg, Germany, died on October 9, at fifty-seven years of age. Prof. Richter was well known among palæobotanists and geologists by his studies of the Cretaceous flora of Quedlinburg, of which he brought together extensive collections. He was the author of the following papers, among others:—"Die Gattung Credneria und einige seltnere Pflanzenreste" (1905), "Die Gattung Hausmannia Dunker" (1906), "Die Gattung Nathorstiana P. Richter und Cylindrites spongioides Goeppert" (1909), all of which are richly illustrated.

THE death is announced, at seventy-eight years of age, of M. Louis Grandeau, the distinguished French agricultural chemist, and author of the "Traité d'analyse des matières agricoles," perhaps the best known book of its time on agricultural analysis. M. Grandeau was one of the last surviving disciples of Boussingault, and maintained throughout the breadth of view and the lucid style of exposition that had characterised the master. He played a great part in the development of scientific agriculture in France, and held various high offices, such as the directorship of the Station agronomique de l'Est, a professorship at the Conservatoire nationale des Arts et Métiers, and was Inspecteur général des Stations agronomiques. He carried out numerous field experiments at L'École Mathieu de Dombasles, Nancy, and later at the Parc-aux-Princes, near Paris, and elsewhere, dealing with the effect of fertilisers on soils and on crops. He also made numerous investigations on the feeding of horses, especially of draft horses, his attention being attracted to this subject by his connection with the laboratory of the Compagnie générale des Voitures, Paris. There was no academic aloofness about M. Grandeau, and he recognised that the final test of his results must be their actual value to the practical man. Accordingly, he used the Press freely to disseminate his ideas; he was chief editor of the *Journal d'agriculture pratique*, and agricultural editor of the *Temps*. His main work was with technical problems. Of his more purely scientific work, perhaps the best known dealt with the black humic material that he extracted from soil, and regarded as an important agent in the nutrition of plants, a view, however, that has since undergone considerable modification.

THE first part of the plant protection scheme of the Selborne Society was to enlist the sympathy of the education authorities throughout the country, and the society has met with a hearty response to its suggestion that the authorities should distribute special leaflets to schoolmasters and schoolmistresses, and put up a card of advice to children in their schools. Many thousands of leaflets and cards have been asked for, and as the Selborne Society has authorised its plant protection section to apply any funds which it may receive to the furtherance of its own work, the society is now making an appeal to all those who desire to preserve the British flora to send subscriptions to the secretary at 42 Bloomsbury Square, London, W.C.

IN view of the reorganisation of the Aëronautical Society, a circular has been issued to members stating that persons desirous of joining the society as members under the old regulations (entrance fee 1*l.* 1*s.*, annual subscription 1*l.* 1*s.*) are still eligible if the application form is returned before November 1, 1911. A number of physicists, engineers, and others have already availed themselves of this privilege, including the Marquis of Tullibardine, the Hon. Maurice Egerton, Mr. Lionel de Rothschild, Profs. Archibald Barr, C. V. Boys, and H. F. Lunn, Captains A. H. Grubb and E. L. Gerrard, Lieuts. R. Gregory and C. R. Samson, Sir Charles D. Rose, Dr. W. Watson, and Messrs. Dugald Clerk, G. Holt Thomas, E. T. Willows, and Horace Short. In view of the uncertainty which probably exists as to the lines on which aëronautical problems may be developed in the future, it seems desirable that persons interested in aërial navigation, either on general or other grounds, who may wish to be associated with the future developments of the society should lose no time in putting themselves in communication with the secretaries, 53 Victoria Street, Westminster.

TAKING as his text the fact that the British Museum has recently established a series of free daily demonstrations in the exhibition galleries to parties of visitors, Lord Sudely, in a letter to *The Times* of October 21, headed "The Utility of Museums," strongly advocates the immediate extension of this system to other museums and kindred institutions throughout the country. The demonstrations, or peripatetic lectures, at the British Museum are declared to be admirable, although the attendance on the part of the public is still comparatively small. This, however, it is urged, might be increased by judicious advertising. Weekly demonstrations at the Imperial Institute, and lectures in some of the American museums (for which, except in the case of schools, small fees are charged), are declared to have attained a success far ahead of what was originally expected. Among London institutions, Lord Sudely specially selects the Victoria and Albert Museum and the Natural History Museum as being admirably suited for demonstrations of this nature, which should also be adopted at Kew. Should the officials at these establishments find it impossible to undertake these demonstrations in addition to their present duties, it is recommended that the respective staffs should be strengthened for this purpose. If lectures of this type were once established at all museums, the writer of the letter is of opinion that the attendance of the public would be largely augmented, while the knowledge and culture of the nation generally would be stimulated. As regards the Natural History Museum, it may be pointed out that popular explanatory labels are conspicuously displayed in most of the exhibition; but it may at once be acknowledged that a much larger amount of information could be conveyed (and, if the right persons were found, in a more interesting manner) by means of popular demonstrations.

IT would be interesting to know the condition of large dew-ponds, such, for instance, as that at Chanctonbury Ring, on the South Downs, at the end of the unusually dry summer of this year. Colonel W. Pitt states in the Journal of the Royal Society of Arts for October 20 that, curious to learn how dew-ponds in general have fared, he wrote to inquire of the Royal Engineers, under whose charge is that part of Salisbury Plain which is War Department property. The report received states that "all dew-ponds in the Plain have gone absolutely dry this summer without exception." The officer who supplied this information adds that the ponds are generally, but not always, placed where they will take surface drainage, and consequently they received, no doubt, a certain amount of what little rainfall there has been.

MR. J. R. HENDERSON, the successor of Mr. E. Thurston as superintendent of the Government Museum, Madras, reports considerable additions to the collections during the year 1910–11. On the archæological side the most important are eight gold-plated sheets of copper with figures of Siva and other Hindu gods, dating from the early sixteenth century. A collection of Pandyan gold coins from the south Canara district is one of the most interesting numismatic finds made in recent years in southern India. A large collection of birds, insects, and Mollusca made in the Shevaroy Hills by the superintendent forms a valuable accession. The marine aquarium, stocked with local sea animals and fishes, continues to flourish, the chief cause of mortality among the inmates being fights, in which victory is not always to the strong.

THE National University of La Plata has published in vol. xvii. of the *Revista del Museo de La Plata* a valuable monograph entitled "Los Tiempos Prehistóricos y Protohistóricos en la Provincia de Cordoba," prepared by Senhor Felix F. Outes, the secretary and director of the museum. This museum, founded by Dr. F. P. Moreno, has become, in its palæontological and anthropological departments, one of the most important in South America. It owes much to the collections of the late Dr. F. Ameghino, to which the present report is largely devoted. The writer reviews the collections from the earliest period, the most interesting series being the cave drawings and petroglyphs representing rude animal and other figures. The report—a scholarly production with full references to the literature of the subject—is an important contribution to our knowledge of the earlier civilisation of Argentina.

IN *Man* for October Prof. Flinders Petrie discusses a series of Roman portraits found at Hawara, on the eastern border of the Fayum, a site from which the most important existing specimens of this form of art have been obtained. The custom of decorating mummies with gilt stucco cases was much developed in Ptolemaic times. By the end of the first century A.D. it became the fashion to take the canvas portrait of the dead, which had hung in a frame on the house wall, and to place it over the face of the mummy as a substitute for a conventional stucco head. Wax was undoubtedly the medium for the colour, which was laid on either with a full brush or in a creamy state with short, sloping strokes. The personages depicted are of a mixed type, mainly European, but mingled in some cases with indigenous Egyptians, Syrians, and other Levantines attracted to the Fayum in the course of trade. Lastly, Roman jurisdiction had added an Italian upper stratum of officials, who had no objection to mixing with other local races; and we also find instances of a Spanish or Moresque-Spanish type in this curiously cosmopolitan population.

WITH the exception of one, by Dr. Annandale, on the batrachians and reptiles of Yun-nan, the papers in vol. vi., part iv., of Records of the Indian Museum are devoted to various groups of invertebrates, among which reference may be made to notes, by the same author, on fresh-water sponges from the Poona district of Bombay. One of these, *Corvospongilla burmanica bombayensis*, represents an Indian race of a species originally described from Burma.

THE appointment of Dr. F. A. Lucas to the directorship of the American Museum of Natural History has caused a vacancy in the office of chief curator of the Brooklyn Museum. According to the October issue of *The (Brooklyn) Museum News*, part of the work of excavating and laying the foundations of an extension of the Central Museum is in hand, while appropriations have been made for the erection of a new Children's Museum. A unique exhibit of animals and other organisms injurious to books and libraries was installed during the year. The insects include various larvæ passing under the general name of "book-worms," cockroaches, white ants, silver-fish, and the American spring-tail.

THE invertebrate marine fauna of the South Sandwich group (lying to the east of South Georgia) forms the subject of several short communications in series 3, vol. xiv., of the *Anales del Museo Nacional de Historia Natural de Buenos Aires*. In a general account of the history of the islands, which bears no author's name, although in the table of contents it seems to be attributed—apparently incorrectly—to Mr. Chevreux, it is recalled that the Sandwich group, which was discovered by Cook in 1755, consists of twelve islands, or rocks, situated in 58° S. lat. Most of the specimens were collected by Dr. F. Lahille, of the La Plata Museum, but others were obtained by Captain Larsen. The majority of the isopod crustaceans were examined by Miss Harriet Richardson, who describes two new species of Serolis, but a new Antarcturus is named in the article which bears no author's name. The amphipods comprise a new Œdiceroides and Eusirus, described by Mr. E. Chevreux; but the pynogonids, which were submitted to Mr. E. Bouvier, all pertained to previously known forms.

IN view of the attention now concentrated on the brown rat in connection with the spread of bubonic plague, and the damage inflicted by this rodent on agricultural produce, Mr. Newton Miller, of Clark University, has undertaken an investigation of the rate of its propagation, the results of which are published in the October number of *The American Naturalist* (vol. xlv., p. 623). From this it appears that these rats, which have a gestation period of from 23½ to 25½ days, breed in every month of the year, and may produce five or six litters annually, the number of young ranging from six to nineteen, and averaging between ten and eleven. Although full growth is not attained before the eighteenth month, sexual maturity is reached in both sexes at least as early as the end of the fourth month. In one particular instance seven litters were produced in as many months by a single female; and in cases when all the young perish at birth, it is presumed that there would be a dozen litters in the course of a year. In captivity brown rats devour nearly 50 per cent. of their young at birth, most, if not all, of these being eaten by the females. Full details are given in the article with regard to the growth and development of the young.

THE current issue (Bd. 43, Heft 3) of the *Morphologisches Jahrbuch* contains a description, by Dr. H. Bluntschli, of an ovarian dermoid cyst in which teeth of two dentitions are recognisable; and studies by G. P. Frets on variations in the vertebral column of fruit bats and squirrels, and by Dr. Kriegbaum on the anatomy of the pharynx of certain mammals, birds, and reptiles.

IN the *Zeitschrift für wissenschaftliche Zoologie* (Bd. 98, Heft 3) J. Sokolow gives an account of the eyes of Pantopoda ("sea spiders"), which he considers to be more primitive in structure than those of arachnids. Drs. Löhner and Micoletzky describe two new acœlous turbellaria, namely, a new genus, Monochœrus, and a new species of Convoluta (*C. pelagica*). The latter is light green in colour, owing to the presence in the parenchyma of clumps of symbiotic plant cells (zoochlorellæ). This worm, which is very voracious, feeding on pelagic copepods, was taken in numbers off the west coast of Istria.

THE source of Chinese medical rhubarb is discussed by Dr. C. C. Hosseus in an article—received as a separate pamphlet—appearing in *Archiv der Pharmazie* (vol. ccxlix.). The strongest evidence is put forward in a statement received from Mr. E. H. Wilson that *Rheum officinale* furnishes the commodity supplied from Tachien-lu, while the best quality, taken from a variety of *R. palmatum*, is exported from the Suntang region.

As in the Malay Archipelago, so in Siam, the family of Dipterocarpaceæ is predominant in the forests; but whereas species in the former region are numerous, only nine are recorded from Siam in the recent account provided by Mr. F. D. Ryan and Dr. A. F. G. Kerr in the Journal of the Siam Society (vol. viii., part i.). Of six species of Dipterocarpus, *D. tuberculatus* and *D. obtusifolius* are the most important, as they form in some localities almost pure, open jungle forests. *D. tuberculatus* is best developed on red clay; *D. obtusifolius* becomes dominant on sandy soil, while *Shorea siamensis* may also develop into forest on stony ground. Different forms, respectively tomentose and glabrous, were observed for several species; the tomentose form is associated with higher and drier situations. A peculiar feature is the storage of water by *D. obtusifolius*, so that if the stem be cut and turned upside down, a sufficiency is obtained to be serviceable to shooting parties.

OWING to the propensities of native growers and the traditions of the industry, the improvement and increase of cotton cultivation in India is a complicated problem; but, judging from the note compiled by Mr. B. Coventry, and published as Bulletin No. 26 of the Agricultural Research Institute, Pusa, appreciable success has already been attained with some measures, while others are proceeding favourably. The yield of Broach and other better-class native varieties has been improved by seed selection; coincidently stores have been established for distributing the pure improved seed. Promising results have been obtained by hybridisation at Surat and elsewhere. In Sind a good-class American cotton has been profitably raised, and Egyptian metafifi is being tried where canal irrigation is feasible. A signal failure is noted in the case of experiments with tree cottons, which have therefore been discontinued.

THE September number of *The American Journal of Science* contains an account, by Mr. O. A. Derby, of a big diamond recently obtained from the Bagagem district of Minas Geraes, where the famous "star of the south" was found. That stone weighed 255 carats; and the same locality also yielded the "Dresden diamond," with a weight when uncut of 119½ carats; the new stone, "estrella de Minas," weighs 175 carats. All three diamonds are elliptical in shape, with curved faces. It is mentioned in the same note that the largest diamond known from Brazil was one found in 1906, the weight of which was estimated at 600 carats. Its owner, being doubtful whether it was really a diamond, caused it to be struck with a heavy hammer on an anvil, in the belief that if genuine it would be uninjured! Fragments weighing about 100 carats were saved, from which one diamond weighing 8 carats was cut.

THE valuable meteorological charts published by the U.S. Weather Bureau for the large oceans and the great American lakes for November have been received. In addition to the usual statistical and other useful information contained on the face of the charts, the reverse sides of those of the North Atlantic and North Pacific contain articles on the sea surface and air temperatures, currents, &c. It is shown, *inter alia*, that high barometric pressure usually prevails over the central portion of the North Atlantic, the crest lying between longitudes 25° and 40° W., having slightly increased since October. Low barometric pressure obtains north of 55°, between longitudes 20° and 50° W., having decreased since October. The increased steepness of the barometric gradient causes frequent storms over the Transatlantic routes.

A SUMMARY of the weather issued by the Meteorological Office shows that the rainfall for last week was again generally below the average, the only really appreciable excess being 0·48 inch in the south of Ireland. Contrary to recent experience, the duration of bright sunshine was below the average over the entire kingdom. The aggregate rainfall for the seven weeks of autumn as yet expired is below the average over the entire kingdom, except in the Channel Islands, where there is a slight excess, amounting to 0·09 inch. The deficiency in the west of Scotland is 3·59 inches, and in the north of Scotland 3·54 inches. The deficiency of rainfall since the commencement of the year is very great; in the north of Ireland it amounts to 8·76 inches, the west of Scotland 7·88 inches, the south-west of England 7·76 inches, and the Midland counties 7·70 inches. In the south-east of England the deficiency is 5·72 inches, where the excess of sunshine is 335 hours, which is the greatest excess in any part of the kingdom. The heavy rains of the present week will decrease somewhat the accumulated deficiency of rainfall.

ACCORDING to several communications which have been made to the *Physikalische Zeitschrift* recently, Drs. Elster and Geitel have succeeded in increasing the sensitiveness of the potassium photoelectric cell very materially by passing an electric discharge for a short time through the hydrogen in the tube. The potassium becomes covered with a greenish-blue film, which appears to give off negative electrons when illuminated much more readily than the metal itself. If the hydrogen remains in the tube the film disappears, and the sensitiveness of the cell falls. By replacing the hydrogen after the formation of the film by argon, the film becomes permanent and the sensitiveness constant. By covering the ordinary potassium kathode with a film of colloidal potassium a cell may be made sensitive to the infra-red rays. As an example of the use to which these sensitive cells may be put, the measurement of the decrease of the light from the moon during the eclipse of November 16, 1910, may be cited. With 232 volts on the cell full moonlight gave a current of 350×10^{-9} ampere, which sank to 220×10^{-9} as the moon entered the umbra, and to zero before totality was reached, owing to the passage of clouds.

THE Sociedad Matemática Española is to be congratulated on the success that is attending its efforts to remove a reproach from the annals of Spanish science. It was founded in April last, and has already published three numbers of its *Rivista*, a periodical which should play a notable part in the awakening and sustaining of mathematical interests throughout the peninsula. Each number opens with a biography and portrait, contains articles on pure and applied mathematics, reviews of current mathematical literature, articles on the history and methodology of the science, and a column for queries and answers. The society proposes to publish for the benefit of its members translations of foreign works on mathematics. This, when finances allow, is to be at less than cost price. On the same terms the society will supply to members translations of articles from foreign periodicals. A department has also been organised for the supply to members of references from the vast body of mathematical literature. The outlook is full of promise, especially when we remember that a much larger audience than Spain can at present produce awaits the appeal of the Sociedad in the intellectual centres south of the United States and north of the line joining Buenos Ayres and Valparaiso. The new society is a vigorous bantling. Time alone will show if it will rise to its opportunities. All information may be obtained from D. Jose Mingot, San Bernardo, 51, Madrid.

IT is well known that the method of preparing nitrous oxide, which consists in heating ammonium nitrate, is not exempt from danger. A new and safer method of preparation, which gives a pure product, is described by A. Quarkaroli in the *Gazzetta Chimica Italiana* for September 19. It consists in heating 0·5 gram of nitre with 20–25 c.c. of formic acid, and collecting the gas which is evolved over a 20 per cent. solution of potash, which serves to absorb the carbon dioxide simultaneously formed. The heating must be done carefully, and it is best to apply a flame until the action just begins, and then remove it at once. When the action ceases another 0·5 gram of nitre is added to revive it, and this is continued until all the formic acid is used up. The action takes place quantitatively according to the equation

$$2KNO_3+6HCO_2H=N_2O+4CO_2+5H_2O+2HCOOK,$$

and this enables the decomposition to be applied to the estimation of nitrates. The action is carried out in a test-tube, and the gases collected over mercury in a graduated cylinder capable of taking 250 c.c.; the volume of mixed gases is first measured, and then the volume obtained after absorbing the carbon dioxide by introducing 2 c.c. of a concentrated solution of potash. The two measurements serve to control one another. The time occupied in an analysis by this method does not exceed five minutes, and as the results are practically as accurate as those obtained by the Schulze-Tiemann method, which takes an hour, the new method is to be preferred. In a second paper it is shown that the action involves initially the formation of nitrous anhydride, which then acts catalytically, and greatly accelerates the velocity of the change. By the addition of traces of substances such as chloric acid, hydrogen peroxide, or potassium permanganate, which destroy nitrous acid, the decomposition of the formic acid is greatly retarded; urea behaves in the same way, but is not quite so active.

A COPY has been received of the "Collective Index of the Institute of Brewing," which forms an exhaustive book of reference to scientific work carried out in connection with the fermentation industries in all parts of the world. The original Laboratory Club first issued Transactions in 1887, so that the index covers the period 1887–1910. It is divided into an authors' index of 130 pages and a subject index of 415 pages, figures which suffice to indicate the enormous amount of work which has been done in connection with fermentation. Besides the publication of original papers and the discussion on them, the institute has included for some years appropriate abstracts of scientific papers in its volumes, and great praise is due to the editor and his colleagues for the efficient way in which this work has been performed. As a consequence, it is possible to keep more easily in touch with the scientific literature of fermentation than is the case in any other industry, and the collective index will make the journal of the society indispensable to future workers in this field. The matter is printed exceptionally clearly across the page, a method which, in our opinion, is far preferable to the double columns adopted by many other societies.

A PAPER on the endurance of metals was read by Messrs. E. M. Eden, W. N. Rose, and F. L. Cunningham before the Institution of Mechanical Engineers on Friday, October 20. The experiments, which were carried out at University College, London, took the form of determining the number of alternations of stress which a loaded rotating beam could withstand before rupture. The most remarkable point shown in these tests is the absence of all speed effect between 250 and 1300 alternations per minute. In the experiments of Reynolds and Smith a very large and perfectly definite speed effect was found for speeds between 1300 and 2000 alternations per minute. The entirely different results of the University College tests must be due to the different form of test and testing machine.

SOME interesting figures are quoted from the report on breakdowns of various generating plants by Mr. Michael Longridge, chief engineer of the British Engine, Boiler and Electrical Insurance Company, in the leading article in *Engineering* for October 20. Two similar gas engines, built by the same maker, and bearing consecutive numbers, were at work 100 miles apart, and broke their crank-shafts on the same day. The cause was bad design, the calculated stress being 21,000 lb. per square inch. Two cases of extraordinary endurance of cast iron are given, in both instances used for parts to which no one nowadays would venture to apply it. One of the cases was that of a cast-iron crank-shaft of an engine built in 1850. Between 1850 and 1873 the engine made 70,000,000 revolutions, and the stress on the neck at the beginning of the stroke was 3650 lb. per square inch; between 1873 and 1897 76,000,000 revolutions were made, the stress being 2270 lb. per square inch; between 1897 and 1910 41,000,000 revolutions were made with a stress of 2050 lb. per square inch. The other instance noted is that of a cast-iron gudgeon, which dated from before 1838. It has withstood, without fracture, at least 750 million applications of a stress equal to ± 1500 to 1700 lb. per square inch.

MESSRS. REYNOLDS AND BRANSON, LTD., of Leeds, have issued an abridged catalogue of chemical apparatus and chemicals containing additions and corrections to the eleventh edition of their catalogue of chemical and physical apparatus.

THE Emil Busch Optical Company, 35 Charles Street, Hatton Garden, London, E.C., has issued several well-illustrated pamphlets giving detailed particulars of the "bis-telar" objectives, of the Busch projection apparatus, and telephoto lenses.

PROF. BIRKELAND asks us to state that the times from U.S. Coast and Geodetic Survey stations given in his letter "On the Simultaneity of Certain Abruptly-beginning Magnetic Disturbances" in NATURE of October 12 (p. 483) should have been in decimals of a minute and not in minutes and seconds; the correct times are thus:—Honolulu, 10h. 20·7m.; Porto Rico, 20·8m.; Cheltenham, 21·9m.

OUR ASTRONOMICAL COLUMN.

MARS.—In No. 4530 of the *Astronomische Nachrichten*, where M. Jarry Desloges's note concerning the brightness of Libya on October 12 is now published, there is also a message from Señor Comas Sola saying that on October 11 he observed a brilliant cloud on the Libya area.

M. Jarry Desloges also continues his preliminary account of the observations made at Massegros during the present opposition, and directs attention to numerous changes of appearance since 1909. A number of important "canals" are seen in the L. Mœris region, the lake itself presenting a variegated appearance. M. Cimmerium and M. Sirenum, seen under good conditions, appear as mosaics, while the L. Solis, although in a very pale region, is relatively dark and is surrounded by a complicated system of "canals"; it is constricted in the middle, and the eastern half is ever the darker. The "canals" around this lake appear abnormal, being very broad, diffuse, and pale. The south polar cap is still seen, but is very small, although at times very brilliant, and the north polar cap presents very sharp fluctuations of relative visibility, extent, and tone. The bluish tone seen in 1909 is still there, but seems to be more brilliant where the edges are better defined.

BELJAWSKY'S COMET, 1911*g*.—Dr. Kobold's ephemeris for comet 1911*g* is continued in No. 4530 of the *Astronomische Nachrichten*, from which we take the following abstract:—

Ephemeris 12h. M.T. Berlin.

1911	α (true) h. m.	δ (true) ° ′	log *r*	log Δ	mag.
Oct. 26	15 27·3	– 9 12·7	9·7483	0·1309	4·3
„ 30	15 44·4	–13 13·0	9·8118	0·1649	4·8
Nov. 3	15 58·9	–16 36·8	9·8669	0·1961	5·2
„ 7	16 11·6	–19 32·0	9·9149	0·2266	5·6
„ 11	16 23·0	–22 3·2	9·9573	0·2507	5·9
„ 15	16 33·4	–24 15·3	9·9951	0·2744	6·2
„ 19	16 43·1	–26 11·9	0·0291	0·2960	6·5

The comet, then, is travelling down through Libra towards Scorpio, and its increasing south declination, its apparent proximity to the sun, and its decreasing brightness make it an almost impossible object except under the best conditions.

A number of earlier observations are recorded in the same journal, the general result being that about October 1–3 the comet was between the second and third magnitude, had a nucleus of magnitude 6·0, and a well-defined tail some 2° or 3° in length.

QUÉNISSET'S COMET, 1911*f*.—New elements and an ephemeris for comet 1911*f* are published by Dr. Ebell in No. 4530 of the *Astronomische Nachrichten*.

Ephemeris 12h. Berlin M.T.

1911	α (true) h. m.	δ (true) ° ′	log *r*	log Δ	mag.
Oct. 24	15 42·2	+22 10·8	9·9378	0·1019	6·8
„ 28	15 43·8	+17 47·8	9·9230	0·1259	6·8
Nov. 1	15 45·0	+13 47·6	9·9109	0·1483	6·9
„ 5	15 45·8	+10 6·0	9·9020	0·1688	6·9
„ 9	15 46·4	+ 6 39·1	9·8969	0·1872	7·0
„ 13	15 46·8	+ 3 24·1	9·8960	0·2034	7·1

Perihelion passage takes place on November 12·39, and the comet is still observable, with increasing difficulty, in the evenings. The path lies through Serpens, and the comet will pass between β and γ Serpentis on October 29–30.

BROOKS'S COMET, 1911*c*.—Some photographs of Brooks's comet, taken by MM. Quénisset and Baldet at the Juvisy Observatory, are reproduced in the October number of *L'Astronomie*. One, on plate paper, taken with 2h. 3m. exposure on September 29, shows a large round head with two fine, slightly divergent streamers; between these, and at about 21′ from the nucleus, emerges the main tail, which presents but few of the undulations and condensations that characterised the tail of Morehouse's comet. A photograph taken with a short-focus camera on September 29 shows a tail 30° long going to the edge of the plate. The photographic intensity of the comet was then much greater than that of Daniel's comet, 1907*d*, but less than that of Morehouse's, 1908*c*.

THE CAPE OBSERVATORY.—Mr. Hough's report of the work done at the Cape Observatory during last year refers to many important pieces of astronomical research, from which we may but select one or two of the more striking facts. The travelling wire micrometer, in a modified form, was fitted to the transit circle, and gave excellent results; an instantaneous reversing gear has been fitted for use on stars near the pole. The heliometer was used on thirty-five nights for securing 166 observations of the position of Halley's comet. With the four-prism spectrograph attached to the Victoria telescope, 239 stellar spectra were secured, and with the one-prism spectrograph eleven photographs of the spectrum of Halley's comet were taken. The 6-inch equatorial was also used on the comet; and its mounting also carried other cameras, one, a Ross-Goertz (F=7·7) camera, having the large prism from the four-prism spectrograph mounted objectively; with this twenty photographs of the comet's spectrum were obtained, some showing also the tail. The astrographic reductions were submitted to the final control afforded by measures on overlapping plates. With the Dallmeyer photoheliograph 550 photographs of the sun were secured on 260 days between March 1 and the end of the year.

THE SPECTRUM OF P CYGNI.—The enigma presented by the mixed spectrum of P Cygni is somewhat further complicated by a preliminary note published by Mr. P. Merrill in No. 201 of the Lick Observatory Bulletins. It will be remembered that the spectrum is of the Orion type, with adjacent bright and dark lines, the latter being displaced toward the violet. Mr. Merrill now finds that the bright lines due to silicon are differentially displaced. Assuming that the wave-lengths of the bright lines of H, He, and N in the spectrum are those found for the same lines in laboratory and ordinary stellar spectra, the three bright silicon lines 4553, 4568, and 4575 are displaced 0·26 A.U. towards the red; the lines are also said to differ appreciably in appearance from the other lines in the spectrum.

MUSEUM CONFERENCE AT LIVERPOOL.

A CONFERENCE of members of the Museums Association and others interested in the work of museums was held at the Public Museum, Liverpool, on Wednesday, October 18. About sixty were present, including representatives from public museums at Manchester, Sheffield, Hull, Leicester, Stoke-on-Trent, Bolton, Warrington, and other towns.

After an address of welcome by Mr. F. J. Leslie, chairman of the libraries, museums, and arts committee, Dr. Clubb, director of museums, gave a brief description of the collections, and conducted the party on an inspection of the galleries. After tea the chair was taken by Mr. H. R. Rathbone, chairman of the museum subcommittee. Mr. E. Rimbault Dibdin directed attention to a clause in the Copyright Bill which has passed the House of Commons, the effect of which would be to take away the copyright in any work of art exhibited in a public gallery, and appealed to museum authorities to agitate for its rejection.

Dr. Clubb read a paper on the educational value of museums for schools, which was illustrated by the exhibition of some of the cabinets of natural history specimens which the museum circulated amongst the elementary schools of Liverpool, and by a number of drawings, wood carvings, and plasticine models made by pupils of one of the schools after a visit to the African gallery of the museum. Mr. P. Entwistle described the introductory series to the ceramic gallery in the Liverpool Museum, which exhibits the development of pottery from the earliest times, and includes a technological series explaining the process of manufacturing earthenware as now carried on. Mr. W. S. Laverock, in a paper on the botanical gallery of a public museum, said that he was forecasting an arrangement which did not as yet exist anywhere, which should include exhibits of English plants grouped according to their habit. This method would be more intelligible to the beginner than the usual systematic arrangement. Mr. J. W. Catmore described modern methods in taxidermy, which he illustrated by means of work in process and with examples of old and new specimens from the collections. The chairman suggested the desirability of adding pictorial backgrounds to some of the naturally mounted groups.

NEW BUILDINGS OF THE ROYAL ALBERT MEMORIAL UNIVERSITY COLLEGE.

FRIDAY last, October 20, was a red-letter day in the history of education in Devonshire, for the formal opening of the new University College buildings by the Lord-Lieutenant of the county was attended by such a gathering of influential people as to show that the County of Devon is now as much in earnest as the City of Exeter itself in the determination to maintain a fully equipped University College in its capital.

Dr. Alex. Hill, late master of Downing College, Cambridge, visitor of the college, delivered an address on the need for the highest branches of education and the importance of bringing such teaching within easy reach of all. Money spent in the establishment, endowment, and maintenance of such colleges, he said, would return to future generations an hundrdedfold. The Lord-Lieutenant, Earl

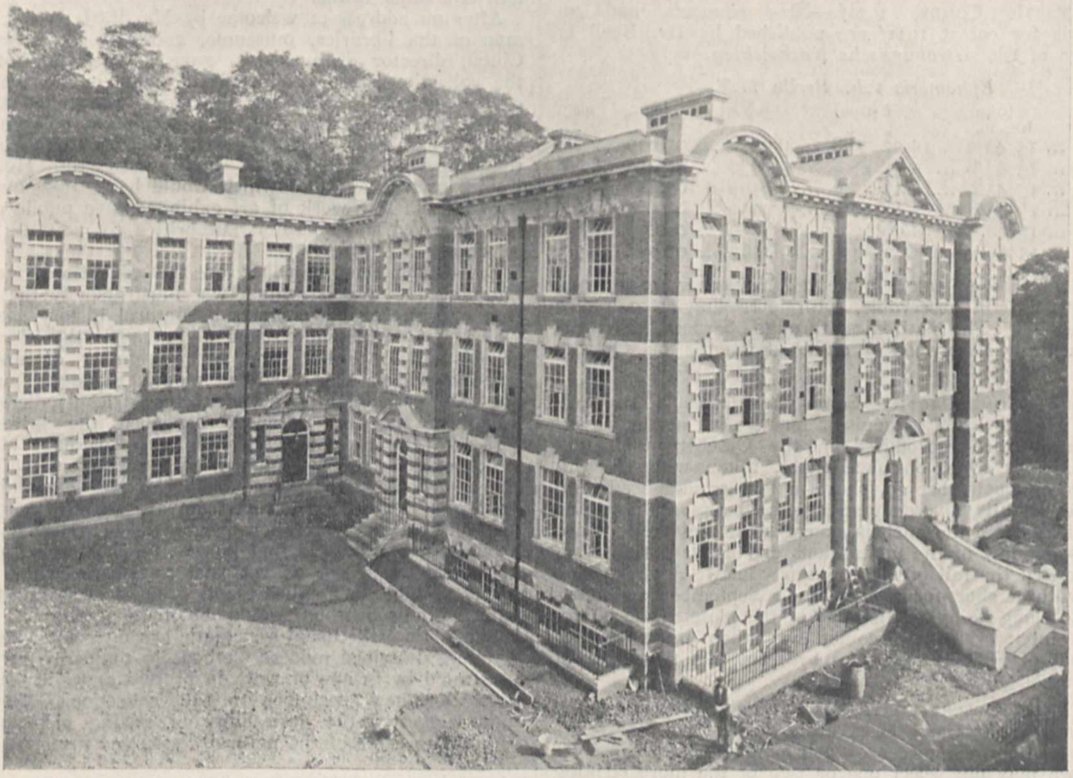
Fortescue, the Bishop of Exeter, Lord Clifford of Chudleigh, chairman of the Devon Education Committee, and the Sheriff of Exeter all followed in the same vein.

Hitherto, as was pointed out by the Mayor and by the principal, the college has been hampered and hindered in its growth by several causes. First among these was the inadequate accommodation of the old class-rooms and laboratories. This difficulty is no more, for the new buildings supply all that is essential for the needs of the present and for several years to come. The other difficulties have been acutely felt from time to time, especially when the commissioners from the Treasury have inspected the college. It had no permanent endowment fund, no long list of subscribers, and no considerable financial backing except from the city and citizens of Exeter itself.

At the meeting on Friday the governors were able to announce that they are making an attempt to raise an endowment fund of at least 30,000*l.*, and the preliminary list already reached more than one-tenth of that sum. It seems certain that when the next inspection takes place the University College will be able to give a very different account of its position.

The buildings opened on October 20 represent the first instalment of a complete scheme for which the site has been secured, as funds do not at present admit of the erection of a great hall or of a wing to give modern accommodation for the fine art, applied art, technical and technological departments.

The front portion of the new wing contains chemical laboratories and lecture theatre, a common room for women students, six class-rooms and lecture-rooms for mathematics, classics, history, English, and modern languages, the biological laboratory and lecture-room, and rooms for the principal, professors, and staff. Behind this lies the day training college. There is no new provision for physics. This will be provided for in the York wing, opened in 1899 during the visit of the King and Queen when Duke and Duchess of York. The whole of this wing will now be devoted to physical science, except for one room allocated to geology.



New Buildings of the Royal Albert Memorial University College, Exeter.

AMERICAN ETHNOLOGY.

ABOUT the year 1895 Major J. W. Powell, director of the Bureau of American Ethnology, decided to prepare a linguistic map of that part of North America south of the Mexican boundary. This important work was, after the death of Major Powell, taken over by Drs. Cyrus Thomas and J. R. Swanton, who have now published the results in the 44th Bulletin of the Bureau of American Ethnology. Their report gives a detailed catalogue of the dialects in use throughout Mexico and Central America. Of particular interest is the evidence now provided, which corroborates the conclusion already arrived at that the linguistic elements of South America, at the time of the Spanish conquest, extended into the southern sections of Central America; and now for the first time the ethnical line dividing North and South America has been provisionally determined. This monograph is admitted not to be a final work, but an attempt to represent the present state of knowledge regarding a subject which may never be cleared entirely of obscurity.

It is a remarkable fact that the Cliff Palace in the Musa Verde National Park, Colorado, the largest, most picturesque, and most typical cliff-dwelling in the south-western States, so long escaped the knowledge of white settlers in the neighbouring Montezuma Valley. It is not mentioned in the early Spanish writings, and the first description of it was not published until about 1880. The classical account of these ruins is that by Baron Nordenskiöld in his "Cliff

Dwellers of the Musa Verde," translated from the Swedish original in 1893. This interesting monument, of which the most remarkable portion is a great round tower, has long suffered from the vandalism of casual treasure-seekers. It has now been taken in hand by the Government of the United States, which deputed Mr. Jesse W. Fewkes to effect a conservative restoration. The results of his operations are described in a valuable monograph, included in Bulletin 51 of the Bureau of American Ethnology. The buildings are prehistoric in the sense that there is no evidence of any culture derived from the white immigrants; and, though the relations of the Pueblo culture to that of the cliff-dwellers is still in some degree uncertain, the latter appears to be the earlier. Of special interest is the question of the disposal of the dead by cremation, the corpse being apparently dried before it was committed to the flames. The religion of this people, of which ceremonial dances formed an important part, cannot be clearly ascertained until the numerous cult objects obtained by excavation are more carefully examined.

GRANTS FOR AGRICULTURAL SCIENCE IN THE UNITED STATES.[1]

THE growth of the National Department of Agriculture during the past ten years has far exceeded that of all of its preceding history. This was pointed out by the Hon. Charles F. Scott, chairman of the House Committee on Agriculture, in submitting the new Agricultural Appropriation Bill last winter. As a full-fledged department with a Cabinet Minister at its head, the Department dates only from 1889. But if we go back to 1839, when 200*l.* was appropriated for "agricultural statistics," and include every dollar appropriated out of the Treasury of the United States for agricultural purposes down to and including the year 1900, the total sum is only 9,020,523*l.*, while the aggregate of all the money appropriated from the end of 1900 to the end of the current fiscal year reaches a sum nearly double this, or 18,002,412*l.* For the fiscal year 1901 the appropriation for maintenance was 660,853*l.* This year the Department has at its disposal 3,094,127*l.* "Ten years ago the total number of persons employed in the Department was 3388; this year if all the rolls were called an army of 12,480 men and women would respond."

Under the Bill submitted by the committee referred to above, which after discussion and amendment received the signature of President Taft on March 4, provision is made for an even greater development during the ensuing year. The aggregate amount carried by the Act is 3,380,003*l.*, which by far exceeds that granted in any previous measure, and is 177,590*l.* in excess of the estimates submitted by the Department.

There is an apparent increase over the Appropriation Act for 1911 of 682,476*l.*, but of this 144,000*l.* is only nominal, since it merely replaces what has hitherto been provided automatically as a permanent appropriation to the State experiment stations under the Adams Act. It will be recalled that by the terms of that Act as subsequently construed in the Appropriation Act for 1907, definite appropriations were made only until July 1, 1911. The action taken by Congress now provides for the continuance of the Adams Fund on the same basis as the Hatch Fund, requiring the amounts to be appropriated annually in the Agricultural Bill. With due allowance for this item, however, there is still an actual enlargement of the appropriations of every bureau, and a net increase of fully 20 per cent. for the Department as a whole.

In general, the increased appropriations are for the purpose of extending and developing lines of work already under way, rather than the undertaking of new projects, and some of the principal increases are for what may be termed the administrative activities of the Department. One of the largest new items is an appropriation of 200,000*l.* for fighting and preventing forest fires in the national forests in cases of extraordinary emergency. This appropriation is in addition to the regular appropriation of 30,000*l.* for fire fighting under ordinary conditions, and supplements deficiency appropriations of more than 180,000*l.* incurred as a result of the disastrous fires of last summer.

The Federal meat inspection, which has been enforced by the Department from a permanent annual appropriation of 600,000*l.*, receives an indirect increase of 31,000*l.* through the transfer of its clerical force to the statutory roll of the Bureau of Animal Industry. The Bureau of Chemistry receives 12,000*l.* additional for the enforcement of the Food and Drugs Act, and the Weather Bureau 15,098*l.* additional for its weather service. Provision is also made by an appropriation of 17,400*l.* for the enforcement of the Insecticide Act, which became effective on January 1, and for which a deficiency appropriation of 7000*l.* had been allowed for expenses to July 1.

A number of propositions involving general legislation were considered in connection with the Bill, but as finally enacted the law remains substantially a routine measure. The secretary was again authorised to continue investigations on the cost of food supplies at the farm and to the consumer, and a special appropriation of 1000*l.* was added for a study of chestnut-bark disease.

The Weather Bureau receives a total of 320,050*l.* Of this amount, 3000*l.* is for the restoration of the Weather Bureau station at Key West, Florida, wrecked by hurricanes in October, 1910. The allotment for maintenance of the bureau printing office was reduced to 3600*l.* by reason of the recent transfer of a portion of the equipment to the Government Printing Office. For investigation of climatology and evaporation 24,000*l.* was provided, as at present.

The appropriations to the Bureau of Animal Industry aggregate 330,150*l.* Aside from the increase due to the transfers from the Meat Inspection Act, previously referred to, the chief additions are those of 1424*l.* for the tick-eradication work, making that appropriation 50,000*l.*; an increase of 1400*l.* for the work of the Dairy Division, making its total 30,000*l.*; and of 1528*l.* for the Animal Husbandry Division, or 9496*l.* for that work. Under a new clause inserted in the Act, the Secretary of Agriculture is authorised to permit, under certain conditions, the admission of tick-infested cattle from Mexico into those portions of Texas below the quarantine line.

New appropriations were made of 13,000*l.* for the purchase of land for quarantine stations near Baltimore, Maryland, and Boston, Massachusetts; 2000*l.* for equipping the 475-acre experiment farm which has recently been acquired at Beltsville, Maryland; and 3300*l.* for constructing buildings at this farm and that at Bethesda, Maryland. It is expected to utilise the Beltsville farm for the experimental work of the Animal Husbandry and Dairy Divisions, and to reserve that at Bethesda for pathological investigations.

One of the largest increases in the Bill was accorded to the Bureau of Plant Industry, which will receive 60,696*l.* additional, making its total 412,337*l.* The lump-fund appropriation for general expenses is 288,307*l.*, which is divided among thirty projects. Some of the largest of these are 70,000*l.* for the boll-weevil campaign (a net increase of 21,389*l.*); methods of crop production in the semi-arid or dry-land sections, and for the utilisation of lands reclaimed under the Reclamation Act, for which a net increase of 7654*l.* and a total of 28,612*l.* is granted; 28,584*l.* for the farm-management studies, of which 800*l.* is to be used in agricultural reconnaissance work in Alaska; studies of the production, handling, grading, and transportation of grains, for which 27,001*l.* is available, an increase of 4900*l.*; and the studies of fruit improvement and the methods of growing, packing, and marketing fruits, which will have 17,547*l.* The investigations of the cotton industry were extended to include the ginning and wrapping of cotton.

For the purchase and distribution of valuable seeds and plants the allotment made was 57,936*l.* This is an apparent decrease of 3982*l.*, but it is accounted for in part by transfers of clerical employees to the statutory roll of the Bureau, and in part by the segregation as a distinct project of 4000*l.*, which was formerly supported from this fund. The two items comprising this appropriation are the congressional seed distribution, which is continued on the usual basis, with 47,432*l.*, and the allotment for the introduction of seeds and plants from foreign countries, which is increased to 10,504*l.*

[1] From the U.S. *Experiment Station Record*, vol. xxiv., No. 5, 1911. The dollars in the original have been converted into English currency.

The appropriations to the Forest Service reached a total of 1,106,620*l*., in addition to the various emergency appropriations to which reference has been made. This, as usual, represents the largest appropriation to any one bureau, and is also the largest increase over the previous year, the total for 1911 having been 1,001,620*l*. The policy of definite allotments to each of the 161 national forests for maintenance was continued. The Nebraska National Forest was authorised to furnish young trees free of charge to settlers in the surrounding region.

The sum of 30,000*l*. was granted for fighting forest fires and for other unforeseen emergencies, of which 14,000*l*. is immediately available. The allotment for permanent improvements on the national forests was increased from 55,000*l*. to 100,000*l*. Provision was made for the refunding to claimants of moneys erroneously collected in the administration of the national forests, and for the granting of easements under certain conditions for rights of way across the public lands, national forests, and reservations for the transmission of electrical power and for telephone and telegraph purposes.

Liberal provision for the development of investigational work was also made, 35,408*l*. being granted for investigations of methods for wood distillation and preservation and the economic use of forest products, including the testing of woods for paper-making, together with 3684*l*. for investigations of range conditions within national forests and range improvement, 50,238*l*. for silvicultural and dendrological experiments, and 6752*l*. for miscellaneous forest investigations and the preparation and dissemination of results.

The appropriation of the Bureau of Soils was increased to 52,412*l*. No appropriation was made for soil-erosion investigations, for which 1000*l*. has been allotted annually for many years. The soil-survey work received 29,000*l*., a net increase of 2608*l*., with a provision added limiting to 10 per cent. the expenditures in any State.

The Bureau was authorised to undertake a new line of work by the appropriation of 2500*l*. "for exploration and investigation within the United States to determine a possible source of supply of potash, nitrates, and other natural fertilisers," 500*l*. being made immediately available. It is expected that particular attention will be devoted to possible sources of potash in view of the present situation as regards the German potash supply. The work will also be supplemented by researches to be conducted by the Geological Survey, which received authority in the Sundry Civil Appropriation Act to expend 8000*l*. "for chemical and physical researches relating to the geology of the United States, including researches with a view of determining geological conditions favourable to the presence of potash salts." According to a recent announcement from the Survey, the expenditure of half this appropriation for the potash exploration is contemplated.

The Bureau of Entomology receives an aggregate of 120,384*l*. This is an increase of 13,948*l*., mainly for the extension of work to the alfalfa weevil and for enlarging the investigations on insects affecting rice and sugar-cane, for demonstration work against forest insects, and for additional studies in bee culture. The largest single allotment is for the continuation of the campaign against the gipsy-moth and brown-tail moth, for which the appropriation is 56,968*l*.

The large proportionate increase of 10,556*l*. was accorded the Bureau of Biological Survey, making its total 27,940*l*. All the various lines of work were continued on a more comprehensive basis, and new items were included of 500*l*. for the purchase, capture, and transportation of game for national reservations, and of 4000*l*. for the feeding, protecting, and removal of elk at Jackson's Hole, Wyoming, and vicinity. The latter appropriation is made immediately available, and remains available until expended.

The activities of the Office of Public Roads have been rapidly increasing in recent years, and to keep pace with the growing demands the appropriation was increased from 22,848*l*. to 32,144*l*. A new line of work authorised is the conducting of field experiments in road construction and maintenance, for which 2000*l*. is granted.

The total appropriation of the Office of Experiment Stations is 372,800*l*., of which 288,000*l*. is allotted to the State experiment stations under the Hatch and Adams Acts. Of the remainder, 11,300*l*. is for statutory salaries, and 7500*l*., a net increase of 1000*l*., is for general expenses. The allotment of 2000*l*. for the Agricultural Education Service was continued as at present.

The nutrition investigations received an increase of 1000*l*., making 3000*l*. available for this purpose. This increase will enable further extension of these investigations and the preparation of popular bulletins setting forth plans for the more economical and effective utilisation of agricultural products as human food, for which data a strong demand has been in evidence.

An estimate of 4000*l*., submitted for the preparation, publication, and dissemination of original technical reports of the scientific investigations of the experiment stations, by the Secretary of Agriculture in cooperation with the Association of American Agricultural Colleges and Experiment Stations, was favourably recommended by both the House and Senate Committees, but failed of passage.

The Alaska, Hawaii, and Porto Rico experiment stations were given 6000*l*. each, an increase of 400*l*. in each case, to equalise their funds with those received by the State stations from Federal funds, and the Guam station was continued at 3000*l*. The clause requiring the expenditure of 1000*l*. by the Porto Rico station for coffee experiments was omitted, thereby restoring the coffee work to the same basis on which it has been conducted for many years previous to the passage of the Act for 1911.

The irrigation and drainage investigations each received 20,000*l*., a net increase of 6564*l*. and 5196*l*. respectively. These increases will enable the extension of these lines of work, especially in the rendering of assistance to settlers in newly irrigated regions and in formulating plans for the reclamation of swamp lands. The provision requiring a special report of the aggregate expenses in the drainage investigations to date, and the areas in the several States and territories which have been investigated, was continued.

The work of the remaining bureaus was provided for along substantially the present lines. Including the increase previously noted for the enforcement of the Food and Drugs Act, the Bureau of Chemistry will receive 13,616*l*. more than at present, and a total of 192,756*l*. The Bureau of Statistics is given 46,324*l*.; the library, 8100*l*.; the office of the secretary, 55,290*l*.; the Division of Accounts, 19,504*l*.; the Division of Publications, 41,992*l*.; and the fund for contingent expenses, 22,000*l*. These all contain small increases, occasioned in general by the growth of the Department.

Eliminating the deficiency appropriations and that for the Forest Reservation Commission, these various appropriations, which are intimately connected with the work of the Department, would if added to the regular appropriations make a grand total of 4,514,003*l*. This is a large sum; but, as was pointed out by Chairman Scott in concluding the presentation of the Bill, "the money appropriated for the Department of Agriculture is an investment and not an expense. And that it has been a good investment the statistics showing the expansion of agriculture and the improvement in methods throughout our country bear eloquent witness. During these past ten years, while the Department of Agriculture has been expending 18,000,000*l*., the farmers of the United States have added to the wealth of the world the stupendous and incomprehensible sum of 16,000,000,000*l*. Without anything like a corresponding increase in the area of land under cultivation, the value of the farm products of our country has risen from slightly more than 800,000,000*l*. ten years ago to nearly 1,800,000,000*l*. in 1910.

"The conclusion is inevitable, therefore—and that conclusion could be made incontestable by innumerable other proofs if time permitted—that the farmers of America are applying better methods and getting better results from their labours than ever before. And in devising these better methods, in pointing the way for better results, the Department of Agriculture has been the undisputed leader, as it should be, and has thus beyond cavil or question derived from the money it has expended a percentage of profit to all the people which cannot be calculated."

THE PHYSIOLOGY OF SUBMARINE WORK.[1]

COMPRESSED air is used in all the great subaqueous works of to-day, in tunnelling, harbour works, shaft-sinking in wet soil, pier- and bridge-building, diving for pearl and sponges, salvage work, &c. The intercommunication of the great cities of the world depends on tunnels built with the aid of compressed air. All such works are limited to a certain depth by the pathological effects produced on the workers.

The Naked Diver.

The naked diver preceded the diver who uses compressed air. The body of the naked diver is pressed upon by the water, equally and in all its parts, by a pressure equal to one atmosphere (15 lb. per square inch) for every 33 feet (10·3 m.) of depth. He takes a deep breath or two, fills his lungs before, and holds his breath during, the dive. He places a foot in a stirrup attached to a heavy stone, and so is carried rapidly to the bottom. The air in his lungs, air passages, and middle ear must be compressed to half its volume at 33 feet (two atmospheres absolute), to one-third at 66 feet (three atmospheres absolute), to a quarter at 99 feet (four atmospheres absolute). The depths attained are usually not greater than 60 to 70 feet. The compression of the air in the lungs is rendered possible by the upward movement of the diaphragm and sinking in of the abdomen. Some of the air in the lungs must dissolve in the blood according to the law of partial pressures.

The amount of nitrogen dissolved from air at one atmosphere pressure and at body temperature is 0·85 per cent. This is the figure for the watery part of the body. The fat dissolves about 5 per cent., an important fact discovered by Vernon. At 66 feet (three atmospheres) the watery part can hold $0·85 \times 3$ and the fat 5×3 per cent. Putting the fat against the solids of the body (bones, &c.), which do not dissolve gas, it may be assumed that the whole body dissolves about 1 per cent. of nitrogen per atmosphere. A man weighing 60 kgm., then, will dissolve when compressed from one to three atmospheres about 1200 c.c. of nitrogen, that is, if time were allowed for the blood to convey the nitrogen from the lungs to the tissues until saturation occurred. In the lungs there are about 4000 c.c. of air. Of course, far less than 1200 c.c. will be dissolved in the minute the diver is submerged. In addition to the solution of nitrogen, the blood will take up more oxygen, both in solution and chemically combined with the hæmoglobin; the diver working hard gathering pearl or sponge will use oxygen rapidly. It is clear, then, that the absolute volume of air must be reduced during the minute the diver stays submerged, but it is difficult to estimate by how much. To allow for the reduction of volume, both by compression and solution, in the body, it is clear that the diver must fill his lungs well, otherwise the diaphragm will be pushed up to such an extent that the action of his heart and the circulation of the blood become impeded. It is this, in part, which sets a limit to the depth to which the naked diver can go. The bleedings from mouth and nose which the unpractised naked diver suffers are due, no doubt, to both the congestion of the blood which results from holding the breath and to rarefaction of the air in the nose and middle ear during the ascent. Some time ago I put this question to Sir E. Ray Lankester: What happens in the case of the whale which sounds, perhaps, to a depth of 1000 feet? Does the whale allow the lungs to fill with water as the air becomes compressed to one-thirtieth of its volume? If not, what is the mechanism engaged which permits such compression? I fancy the whale allows water to enter, and blows this out again when it ascends to the surface. The naked diver can extend his stay under water by deep breathing before the plunge and filling the lungs with oxygen. The breathing is regulated by the concentration of acid (or the hydrogen ion) in the blood—carbonic acid is the natural end product of muscular metabolism; lactic acid is produced in the muscles when there is a deficiency of oxygen. Deep breathing before the dive will wash out much of the carbonic acid in the blood, owing to the increased ventilation of the lungs. The blood and muscles, too, will be better oxygenated, and thus less lactic acid will be produced during the submergence. If oxygen is breathed this will be still more the case, as Martin Flack and I have shown. After deep breathing air for two minutes we easily held our breath two or three minutes. After deep breathing oxygen five minutes one of our subjects held his breath more than eight minutes, and another just above nine minutes. Taking a deep breath and then holding it, J. M. pulled up a 60-lb. weight seventeen times in twenty-three seconds before he was compelled to take another breath. After deep breathing air for two minutes he held his breath while he pulled it up thirty times in fifty seconds, and after deep breathing oxygen for two minutes, seventy times in eighty-five seconds. Similarly, after a deep breath, R. A. R. held it while he ran 113 yards in twenty-nine seconds; 150 yards in 35⅖ seconds after deep breathing air for two minutes; 256 yards in 62⅖ seconds after deep breathing oxygen for two minutes. S. E. ran on one breath 470 yards in 110 seconds after deep breathing oxygen! At the end he ran blindly, having lost consciousness owing to the high concentration of CO_2 in his blood.

The high pressure of oxygen in the lungs enables one to hold one's breath until the pressure of CO_2 reaches 10 to 11 per cent., while if the pressure of oxygen is low a breath must be taken when that of the CO_2 reaches no more than half this amount. A balance is struck between the relative pressures of oxygen and carbonic acid. Mr. I. Feldman here has been breathing oxygen for some minutes; he will now put his face in a basin of water; you see he has now held his breath for three minutes without the least trouble.

It is clear, then, that the naked diver can stay longer and do more efficient work if he deeply breathed and filled his lungs with oxygen before each dive.

I will demonstrate my little apparatus by means of which oxygen can be generated from oxylithe (peroxide of sodium) and inhaled. Two blocks of oxylithe are put in the metal box—the generator—and a pint of water in the rubber bag. The mouthpiece of the bag is clipped, and the water allowed to enter the generator. Oxygen fills the bag, and a solution of caustic soda is formed. The man breathes in and out of the bag. This invention allows oxygen to be carried about, and has proved useful for mountain climbers who at high altitudes suffer from oxygen want.

Diving birds have double the normal volume of blood (Bohr), just as the llama and the human inhabitant of high altitudes have more red corpuscles and hæmoglobin. Observations on the blood of naked divers would probably show the same increase.

The Mechanical Effects of Pressure on the Body.

The body of the naked diver at a depth of, say, 66 feet is pressed upon equally on all sides by the water, and by a pressure of three atmospheres; for 33 feet of water = one atmosphere. The gas in his lungs (and intestines) is compressed into one-third of its volume, and that is the only effect of the pressure, for the pressure is transmitted equally and instantly by the fluids of the body to all parts, and as the fluids are practically incompressible the pressure has no mechanical effect.

The diver who uses gear, or the caisson worker, is surrounded with compressed air, and breathes freely in it. The body of either is pressed upon by the air, and the air pressure must always be just greater than that of the water to keep the latter out of the dress, bell, or caisson. I will demonstrate this on the model diver, diving bell, and caisson. Whether it be air or water that *uniformly* presses upon the body, the tissue fluids transmit the pressure equally; and thus, although it is computed that an extra atmosphere means an additional total pressure of 15,000 to 20,000 kilograms (40,000 lb.) on the body of a man, no mechanical effect is produced. Living matter is a jelly containing about 80 per cent. of water, and, like water, is practically incompressible. Since attention was first directed to compressed-air illness, the larger number of medical writers, ignorant of physical laws, have supposed that exposure to compressed air mechanically alters the distribution of the blood, forcing it inwards and causing a congestion, which is suddenly and dangerously altered on decompression.

[1] Evening discourse delivered before the British Association at Portsmouth on Friday, September 1, by Mr. Leonard Hill, F.R.S.

I have noted that the same false views are even now put forward in the daily Press to explain the symptoms, due to the rarefaction of the air, endured by aëroplanists. The sickness of high altitudes suffered by mountain climbers, balloonists, and aëroplanists has nothing to do with the mere mechanical effect of the lowering of barometric pressure. In an atmosphere enriched with oxygen U. Mosso has endured a lowering of barometric pressure until he could span the height of the column of mercury in the barometer with his hand. Oxygen want, due to the rarefaction of the air, is the prime cause of altitude sickness. At an altitude of 18,000 feet, where the barometric pressure is halved, a man, filling his lungs with air, takes in only half the *weight* of oxygen which he takes in at sea-level. His respiratory and circulatory organs can scarcely work hard enough for the body to get enough oxygen. The extra pulmonary ventilation washes the CO_2 out of the body, and produces a subnormal concentration of CO_2 in the blood and tissues. This is partly the cause of mountain-sickness. Individual variations in immunity to this sickness probably depend on variations in the chemical quality of the blood and power of the hæmoglobin to combine with oxygen.

That mere mechanical pressure, uniformly applied, is of no importance to living matter is shown by the existence of life in the greatest depths yet sounded, where the superincumbent pressure may equal two, three, and even five miles of water. By means of a small chamber and hydraulic pump and lantern I can project the shadow of the frog's heart beating in a suitable salt solution at a pressure of 2000 lb. (133 atmospheres), equivalent to a depth of nearly a mile of water. Regnard has compressed living aquatic animals, frogs' muscles, &c., to 500 and even 1000 atmospheres, and has found at the highest pressures the tissues become stiff and take up water, and life is destroyed. His experimental results and those of the deep-sea soundings (*Challenger* reports) are in contradiction. Regnard's experiments require repetition, with careful attention to the chemical composition of the water in which the living matter is compressed.

I refute the mechanical theories of compressed-air illness by this experiment: a frog's web is stretched over the glass window of the small pressure chamber, and is illuminated by the arc light, so that the circulation of the blood is projected on the screen. The circulation remains unchanged when the pressure is rapidly raised to twenty or even fifty atmospheres.

Manometric records of blood pressure taken from mammals enclosed in a pressure chamber, or from man, show no noteworthy change when the pressure is raised to three atmospheres. Similarly, I now show that a frog's heart or muscle contracts normally when suddenly submitted to a pressure of air equal to fifty atmospheres. After a time the contraction languishes; but that is not due to the pressure *per se*, but to poisoning by the high pressure (concentration) of oxygen. The pressure uniformly applied has no mechanical effect on the living protoplasm.

The Evolution of Diving Apparatus.

The use of compressed air for submarine work was a matter of slow development, owing, not to lack of invention, but to want of efficient air pumps and flexible tubes. The naked divers had a barrel, or bell-shaped vessel, standing on a tripod, lowered down to them full of air, to which they could return and breathe the air within every minute or two. They also chewed pieces of sponge dipped in oil, probably because swallowing inhibits the respiratory centre and checks the desire to breathe. One of the oldest inventions is that of a pipe conveying air from the surface to the mouth of the diver. Such a device cannot be used at any depth, because the body is pressed upon by the water plus the atmospheric pressure, while the lungs are exposed to the atmospheric pressure alone. This makes breathing difficult, and dangerously congests the lungs with blood, as I can demonstrate by this model. The cupping glass also demonstrates the congestive effect produced by lessening the atmospheric pressure at one part of the body only. Bernouilli (seventeenth century) formulated the correct theory that the diver must be supplied with air at the pressure of the water surrounding him. In the older inventions the air escaped from under the helmet, and only the head was dry. The air pressure in the modern diving dress (invented by Siebe), regulated by a valve in the helmet, keeps the water from entering at the wrist cuff, and the whole body is kept dry and warm and equally compressed. I demonstrate the modern diving dress which Messrs. Siebe, Gorman and Co. have lent me for this lecture. The pressure produced by the pump must keep up to that of the water as the diver descends, so long as he does not fall down. He can descend rapidly, *e.g.* 100 feet in two minutes; but it is dangerous to fall down, for if the pump does not keep up with the water pressure a cupping effect is produced, and the diver may suffer hæmorrhage from the lungs and mouth and nose.

By means of the escape valve the diver can adjust his specific gravity so that he is only slightly heavier than water, and can move easily along the bottom. He fills his dress more or less with air, just as the fish fills its swim bladder. If the dress becomes over-filled the diver is "blown up" to the surface; and in the old style of dress he may become helpless, arms and legs blown out stiff, unable to open his valve. You see how this happens in the case of the model diver. To prevent this accident the legs of the latest fashionable dress are laced up, as I now show you.

The Diving Bell and Caisson.

Anyone who pushed an inverted glass under water and saw it did not fill would conceive the idea of a diving bell. Sinclair (1665) fashioned a simple wooden bell to recover treasure from an Armada ship off Mull. At 33½ feet the air in such a bell is compressed to half its volume, and this, together with lack of ventilation, rendered such a bell of little use.

Halley, the astronomer, used a pipe and bellows for shallow work, while for deep work, when his bellows failed, he sank a cask full of air to a deeper level than the bell. From the cask to the bell passed a tube, and the water, entering the cask through a hole, displaced the air into the bell (model demonstrated). He descended to nine to ten fathoms with four others, and used up seven to eight barrels of air.

With the building of efficient air-pumps, Smeaton (1778) applied the bell to the important use of building the piles of bridges. Triger (1839) applied it to the sinking of coal shafts through quicksands, and the bell became thus evolved into the modern caisson—a steel chamber provided with a cutting edge below and an air-lock above for allowing the men to enter and leave without raising the bell. Finally, the caisson was applied to the purpose of horizontally tunnelling under rivers. To effect this a steel shield provided with cutting edge is driven forward by hydraulic jacks. Screens are placed in the shield to allow excavation of the soil in front of it. As fast as the shield is driven forward, segments of the iron tunnel are built into place. Water is kept out of the work by the use of compressed air. On entering, the men are "compressed" in the air-lock, *i.e.* the air pressure is raised to that in the tunnel, and on leaving the tunnel they are "decompressed," *i.e.* the air pressure is lowered in the lock down to the normal, so that the outer door of the lock may be opened.

A diver is "compressed" on descending into the water, as the pressure of his air-pump always keeps up to that of the water. On coming up he is "decompressed."

The Ventilation of the Diving Dress.

Divers in deep-sea water have in the past been unable to stay down long owing to a feeling of oppression, which they have ascribed to the pressure of the water. M. Greenwood and I have exposed ourselves in our compressed-air chamber to +92 lb. (seven atmospheres) and +75 lb. (six atmospheres) respectively, and found our breathing just as free and easy as at atmospheric pressure. Beyond the increasing nasal twang of the voice there are no symptoms produced, and there is no sense by which the pressure can be estimated. John Haldane has done great service in proving that the cause of the oppression is due to increased partial pressure of CO_2 in the helmet owing to deficient ventilation. The breathing is regulated by the pressure of CO_2 in the lungs, so that this is kept at 5 to 6 per cent. of an atmosphere. During work the amount of CO_2 given off is trebled or quadrupled, and during hard work it may be increased sixfold. The ventilation of the lung is increased *pari passu* so as to keep the percentage of CO_2 in the lung normal.

If the pressure of CO_2 in the inspired air is increased, the breathing is deepened so as to keep normal the CO_2 percentage in the lung. If the inspired air contain 3 per cent. CO_2, the volume breathed is about doubled, and moderate work in such air causes as much panting as hard work in pure air.

When the atmospheric pressure is altered it is not the percentage, but the absolute pressure of CO_2 which controls the breathing. Thus the percentage found in Greenwood's lungs was 5·4 at one atmosphere, 2·7 at two atmospheres, 0·9 at six atmospheres, and the partial pressure of CO_2—*i.e.* the percentage multiplied by the pressure in atmospheres—in each case was 5·4 per cent. of an atmosphere. This holds good also down to about two-thirds of an atmosphere in analyses taken at high altitudes. At lower atmospheric pressures than this oxygen want comes in, with the production of lactic acid in the tissues and blood as a disturbing factor. It is clear, then, that the effect of a given percentage of CO_2 in the diver's helmet varies with the depth. If air containing 5 per cent. CO_2 produces great panting at one atmosphere, air containing $5/7{\cdot}4=0{\cdot}68$ per cent. will produce the same degree of panting at 35 fathoms (7·4 atmospheres). It follows from this that whatever the pressure a diver is under, he requires the same volume of air measured at that pressure to ensure the ventilation of his helmet. At two atmospheres the ventilation must be doubled, at three atmospheres trebled, at six atmospheres increased sixfold. Under the old conditions of working, often with leaky pumps and tired men to pump, the ventilation has been actually less, not six times greater, as it ought to be, at a depth of 165 feet.

With a pressure of 2 per cent. of CO_2 in the inspired air the pulmonary ventilation is increased about 50 per cent., with 3 per cent. about 100 per cent., with 4 per cent. about 200 per cent., with 5 per cent, about 300 per cent., and with 6 per cent. about 500 per cent. If the diver is working hard the extra production of CO_2 will make him pant, and this, coupled with the effect of the excess in the helmet, which often reaches 3 to 4 per cent., makes breathing distressing and the feeling of oppression intense. Thus at a depth of 139 feet with a CO_2 pressure of 4·28 per cent. of an atmosphere, Lieut. Damant was unable to continue for more than eight minutes the exertion of lifting a weight of 56 lb. about 9 feet per minute. The Admiralty Committee found that the divers could continue work for long periods at depths of even 210 feet so long as the CO_2 pressure was kept below 3 per cent. of an atmosphere.

To keep the CO_2 down to this level a diver ought to have at least 1·5 cubic feet of air per minute when working, and he must have this volume of air pass through the helmet at whatever pressure he be at. Each cylinder of the regulation service pump ought to yield one-tenth cubic feet per revolution. Assuming an unavoidable leakage of the pumps of 10 per cent. at 100 feet and 24 per cent. at 200 feet, the Admiralty Committee ordered for 33 feet (depth) one cylinder, thirty revolutions per minute, and two men per spell, the work being estimated at 4440 foot-lb. per minute; while for 165 feet depth four cylinders, twenty-seven revolutions, and twelve men are required, the work being 34,000 foot-lb. per minute; for 198 feet (depth) six cylinders, twenty-three revolutions, eighteen men, the work being 43,000 foot-lb. per minute. Provision ought to be made to give a third more than this supply if the diver gets into difficulties.

At 210 feet thirty-six men were working very hard in alternate five-minute spells of rest and work, and were scarcely able to keep up the proper air supply. Long handles were supplied to allow three men on each side of the pump.

To avoid this excessive labour, R. H. Davis (of Siebe, Gorman and Co.) and I have added to the diving dress this metal box, containing trays of caustic soda. A mouthpiece is placed within the helmet, and a tube leads from this through the soda-box and back to the helmet. The diver when oppressed in the slightest degree can take hold of the mouthpiece with his lips and breathe through the caustic soda, and so lessen the concentration of CO_2. There is no risk of his suffering from want of oxygen so long as the pumps give him a moderate supply of air. This device ought to save a great deal of hard pumping work.

The Self-contained Diving Dress.

We have also contrived a self-contained diving dress fitted with cylinders containing compressed air enriched with oxygen (to 50 per cent.), and a caustic-soda chamber. The oxygen supply is delivered to the helmet by a reducing valve in constant supply (5 litres per minute), and the force of the oxygen stream is used, by means of an injector, to suck the air in the helmet through the caustic-soda chamber. No life-line or air-pipe is carried, only a light telephone cable, and this makes the dress suitable for exploration of flooded mines, tunnels, ships, &c., through which the heavy pipes and lines cannot be dragged. Air containing 50 per cent. oxygen is used in place of oxygen (Haldane), so that there is no risk of oxygen poisoning if used for an hour at depths of 70 to 80 feet, or even 100 feet, for half an hour.

Compressed-air Illness.

In all the great compressed-air works from first to last the men have suffered from illness and loss of life. There is no risk going into or staying in the caisson, as Pol and Watelle (1854) said, "On ne paie qu'en sortant." Out of sixty-four workers observed by them forty-seven remained well, fourteen had slight illnesses, sixteen more or less severe, two died. An absolute pressure of 4½ atmospheres was reached. The men worked two shifts per diem of four hours each, and were decompressed in thirty minutes. At the St. Louis Bridge works, out of 352 workers there were 119 cases, fifty-six of paralysis, and fourteen deaths. The absolute pressure reached 4⅓ atmospheres.

At the Nussdorf works 320 cases among 675 workers, and two deaths; the absolute pressure reached was 3½ atmospheres.

In the East River tunnels (New York), under well-regulated conditions, the percentage of illness was 0·66, of death 0·0035 in 557,000 man-shifts, with a decompression rate of fifteen minutes from an absolute pressure of three atmospheres. Of the 320 cases at Nussdorf, v. Schrötter observed sixty-eight cases of ear trouble, 105 of pain in the muscles, sixty of pains in the joints, ten of girdle pains, seventeen of partial paralysis, twenty-six of paralysis of the lower half of the body, fourteen of vertigo and noises in the ear, two of sudden deafness, one of loss of speech, thirteen of asphyxial phenomena. Out of 3692 cases at the East River tunnels observed by Keays, 88·78 per cent. were pains in joints and muscles, "bends," 1·26 per cent. pains and prostration, 2·16 per cent. nervous symptoms, 5·33 per cent. vertigo, 1·62 per cent. dyspnœa and oppression, chokes, 0·46 per cent. loss of consciousness and collapse. There were twenty deaths. The trouble in the ear, which occurs during compression, is due to the inequality of air pressure on either side of the drum of the ear. It is relieved at once by opening the Eustachian tubes by swallowing, or by a forced expiration with the nose and mouth held shut. None of the other manifold symptoms come on while the men are under pressure. Mules were kept for a year in the Hudson Tunnel at three atmospheres absolute, and were healthy enough to kick and bite at all comers (E. W. Moir). The illness comes in after decompression, usually within a few minutes to half an hour, sometimes even later.

The Cause of the Illness.

The cause of the illness—so striking in its protean nature—was made clear by Paul Bert (1879), who showed by experiments on animals (1) that nitrogen gas is dissolved by the blood and tissue fluids in proportion to the pressure of the air (Dalton's law); (2) that the dissolved gas bubbles off and effervesces in the blood when an animal or man is decompressed too rapidly; the bubbles, by blocking up the capillaries and cutting off the blood supply here or there, produce the symptoms; (3) that during exposure to eight or nine atmospheres there is no ill-effect until the partial pressure of oxygen dissolved in the blood reaches such a point that it acts as a tissue poison; (4) that the illness which occurs on decompression is prevented by making the period of decompression sufficiently slow, by allowing time for the dissolved nitrogen to escape from the lungs. Looking through the works of Robert Boyle, I found that, after the invention of his air-pump, he "had a mind to observe whether when the air from time to time was drawn away, there would not appear some hidden swelling, greater or less, of the body of the animal by the spring and expansion of some air (or aërial matter) included in the thorax or the abdomen." He recorded that a viper's body and neck grew prodigiously tumid; that a bubble of air appeared in the aqueous humour of a viper's eye; that the heart of an eel grew very tumid and sent forth little bubbles; that blood boiled "over the pot" until the blood occupied only one-quarter of the volume of the whole, so great was the expansion of the bubbles given off from it. In the following surmise, concerning the death of animals submitted to rarefaction, Boyle forestalls Bert. "Another suspicion we should have entertained concerning the death of animals, namely, that upon the sudden removal of the wonted pressure of the ambient air, the warm blood of those animals was brought to an effervescence or ebullition, or at least so vehemently expanded as to disturb the circulation of the blood, and so disorder the whole economy of the body."

Hoppe-Seyler (1857) demonstrated bubbles in the blood-vessels of animals submitted to rarefaction. This was denied by Bert, but confirmed in the case of a rabbit by Greenwood and myself.

Out of thirty autopsies done on fatal cases of caisson illness, in nineteen gas-bubbles were visible in the blood-vessels; of the other cases most were old-standing lesions of the spinal cord.

The paralysis so often produced is due to a local death and degeneration of the spinal cord, produced by bubbles blocking the circulation there (v. Schrötter, Heller, and Mager).

Proofs that nitrogen gas dissolved in the body fluids and fat is the cause of the illness are the following. The blood collected from the artery of an animal while under pressure, and analysed with the gas-pump, shows that the amount of dissolved nitrogen varies with the pressure. Roughly, 1 per cent. per atmosphere is dissolved (Bert, Hill, and Macleod).

Exposed to one atmosphere at body temperature, blood dissolves just about 1 per cent. N, to two atmospheres 2 per cent., to three atmospheres 3 per cent., and so on. The tissue fluids take up the dissolved gas from the blood, and with time the whole body becomes saturated, according to Dalton's law. The saturation of the body fluids takes time, since the blood forms but 5 per cent. of the whole body weight, and it is the blood alone that comes in direct contact in the lungs with the increased atmospheric pressure. Probably about 5 kilograms of blood circulate through the lungs per minute, and this blood conveys the absorbed nitrogen to the 60 kilograms of tissues. The arterial blood saturated in the lungs yields the nitrogen to the tissues, and returns to be saturated again in the lungs. Those tissues which are plentifully supplied with blood will become saturated rapidly, while less vascular areas, and parts in a state of vasco-constriction, will saturate very slowly.

C. Ham and I exposed rats to ten to twenty atmospheres, killed them by instant decompression, and then, opening their bodies under water, collected and analysed the gas set free therein. We obtained in this gas CO_2 6·7 to 16 per cent., O_2 2·1 to 8·7 per cent., N 80 to 87 per cent., and a volume of N greater than that calculated according to solubility of N in tissue fluid. Some of the excess we found was due to air swallowed while under pressure, the rest to solution of N in fat.

M. Greenwood and I have tested upon ourselves the rate of saturation, using the urine as a test fluid. We were compressed in a large boiler, placed at our disposal by Messrs. Siebe, Gorman and Co. The chamber was fitted with electric light and telephone, and taps for slow decompression. The pressure was raised by means of a diving-pump driven by a gas engine. We drank a quart of water before entering, and collected samples of urine at varying pressures and times. The urine, collected in sealed bulbs, was evacuated by the blood gas-pump. We found the urine secreted in the next ten minutes after reaching any given pressure is saturated with N at that pressure.

To demonstrate the bubbling off of nitrogen on rapid decompression, I have spread the web of a frog's foot or wing of a bat over the glass window of a pressure chamber. The circulation of the blood is projected on a screen with aid of microscope and arc light. We can thus observe the circulation under twenty atmospheres of air, and watch the bubbles forming in the capillaries on rapid decompression. Recompression diminishes the size, and finally drives the bubbles again into solution.

When the larger mammals are exposed to high pressure, such as eight atmospheres, for an hour or so, and are then rapidly decompressed, they usually die in a few minutes. Small mammals, such as mice and rats, may escape, owing to the small bulk of body and rapid respiration and circulation. The young of rabbits, cats, &c., also escape more frequently than old animals. This is due rather to their smaller weight and more rapid circulation than to the youth of the body tissues. Paralysis in the limbs follows too rapid decompression, or the animals fall over and become unconscious. Noise of gas bubbles gurgling in the heart may be heard. Respiration becomes embarrassed, and the animals die. On dissection, the peritoneal cavity may be found distended with gas, or the stomach, and gas may be seen in the intestine. A part of this gas arises from the fermentative processes of digestion, and from air swallowed during compression. The veins of the portal system, the venæ cavæ, are seen to contain chains of bubbles; the heart is full of froth. Small hæmorrhages may be present in the lungs. The edges of the lobes of the lung are emphysematous, blown out by the rapid decompression. The fat often is full of small bubbles, so too are the connective tissues. Bubbles are seen in the joints, and may appear in the aqueous humour of the eye. On opening the skull, bubbles are seen in the veins of the brain. The bubbles are not restricted to the veins, but may also be seen in the arteries. The coronary vessels of the heart often show chains of bubbles. On microscopic examination the bubbles are seen in the capillaries; here and there they run together and form larger bubbles, sometimes rupturing the walls of the vessel and compressing the surrounding tissues. In the larger animals, decompressed from 100 lb. in four to seven seconds, we have found the cells of the liver, kidney, &c., vacuolated or even burst by bubbles. The gas set free in the heart can be collected and analysed; about 80 per cent. of it is found to be nitrogen (Bert, v. Schrötter, Hill and Macleod). Catsaras lowered dogs in a diving dress to depths of 43·7 m., and after about an hour rapidly drew them to the surface. He found bubbles set free in these dogs just as in those exposed in a pressure chamber.

In animals which escape without any severe symptoms, some gas bubbles may be found in the veins even six hours later. This shows how long it may take for nitrogen gas once set free as bubbles to escape from the lungs, and explains why caisson workers may suddenly be seized some half-hour or more after leaving the works. In such cases the bubbles may be swept from the abdominal veins—where they do no harm—into the heart, and impede the action of this organ, or they may penetrate the pulmonary circulation and enter the arterial system, and block up, perchance, the coronary arteries, or others in the brain or spinal cord.

The blood is a colloidal solution, and it takes time for the nitrogen to come out of solution and for the small bubbles to run together to form visible bubbles. The gas bubbles tend to collect in the veins, as the blood travels quickly through the arteries and slowly in the veins. It is only when the gas in the veins becomes sufficient in amount to produce foam in the heart, or when gas bubbles block up arteries of vital import, that grave symptoms arise. The place where bubbles in the arteries must always produce serious results is the central nervous system. In the liver, kidneys, muscles, fat, &c., bubbles may embolise small arteries and produce no grave effect, but in the spinal cord the interruption of the blood supply to any group of cells or tract of fibres is evidenced at once by pain and anæsthesia, spasm, and paralysis. In the medulla oblongata arrest of the circulation will stop respiration, and bubbles lodging there may produce immediate death. Lodging in the arteries of the great brain, bubbles may produce hemiplegia, aphasia, blindness, or mental disturbance.

Among men some are affected and others not. We can look for an explanation in the varying state of the blood, in fatness, in the varying vigour of the circulation and respiration and the effect of fatigue, in vaso-motor changes which alter the relative volume of circulating blood in viscera and muscles, and in the fermentative processes going on in the alimentary tract. The young man who is in perfect health, with powerful heart and deep respiration, can expel the dissolved nitrogen from his lungs far more rapidly than the old, the fat, the intemperate, or one who is over-fatigued by excessive labour. The records of caisson works seem to show that most men under twenty escape, while the percentage of cases increases with age, and is highest for men above forty; that long shifts increase the number of cases; that men who work the air-locks, passing material through, and undergoing frequent and short-lasting compression and decompression, are not affected. The longer the shift the more complete the saturation of the body; the higher the pressure the greater the risks and the graver the symptoms. The records show that practically no cases occur with a pressure below 2 to 2½ atmospheres absolute, even though the decompression period be made only a minute or two.

At the Rotherhithe Tunnel the decompression period was three minutes, and the maximal pressure +22 lb. No cases of any gravity occurred. Nevertheless, we proved that the workers had excess of nitrogen in their bodies after decompression. We gave them a quart of beer to drink in the tunnel thirty minutes before decompression to provoke diuresis, and made them empty their bladders just before, and again ten minutes after, decompression. Their urine yielded more than the normal volume of N. The urine, passed immediately after their decompression, obviously effervesced.

Influence of Fatness.

As the fat holds five or six times as much nitrogen in solution as the blood, it saturates and desaturates slowly.

J. F. Twort and I have found 35·55 per cent. of nitrogen dissolved in olive oil which had been exposed to 7½ atmospheres. The risk of exposure to compressed air varies with the fatness of the animal (Boycott and Damant). Greenwood and I have found fat pigs weighing 100 to 120 lb. are more susceptible than smaller pigs 50 to 60 lb. The bubbles once set free in the subcutaneous fat of pigs may stay there for days after decompression, as we have found to our cost, for it has seriously damaged the sale of the animals to the butcher, since the fat does not bleed white, but remains pink and mottled. All the results prove that fat men should be excluded from compressed-air work at pressures above two atmospheres absolute.

The varying percentage of fat in the blood, chyle, and liver must be an important factor in the evolution of bubbles in the blood. The less fat in the food eaten by caisson workers the better.

Ventilation and Illness.

Much has been made of the impurity of the air as a contributory cause of caisson sickness, in particular, of the percentage of CO_2. The ventilation of the tunnels built by the London County Council under the Thames have been carried out at enormous and needless expense in order to keep the CO_2 percentage down to a very low level. The work of the English physiologists is against this view. Divers generally work with 1, 2, or even 3 per cent. of an atmosphere CO_2 in their helmets. We have exposed ourselves to 3 to 4 per cent. of an atmosphere CO_2 without untoward results, beyond increased frequency of respiration, which prevents any increased concentration of CO_2 in the body.

Recently I have carried out many experiments on students sealed up in a small air-tight chamber, and found, as Haldane has, that it is the heat, moisture, and stillness of the air which cause discomfort and fatigue, and not the excess of CO_2 or deficiency of oxygen in the air breathed. The putting on of powerful electric fans, by whirling the air and cooling the body, gives very great relief, even when there is 4 to 5 per cent. of CO_2 in the chamber.

In open-air treatment the coolness and movement of the air are the essential qualities which promote health by stimulating the activity, the metabolism, and nervous well-being of the body.

Hot, moist, still air causes fatigue by taxing the cooling mechanism of the body; blood is sent to the skin to be cooled which ought to be going to muscle and brain. Fatigue increases the danger of decompression by making the circulation and respiration less efficient. The heat causes more blood to come to the skin and a more complete saturation with nitrogen there. The cold in the decompression chamber—due to expansion of the air—causes vaso-constriction and repels the blood from the skin, and so stops its desaturation. We have lost pigs by taking them from the warm caisson into the cold air.

Over-hot and moist—that is, under-ventilated—caissons have, therefore, a higher morbidity. To secure efficient work, the wet-bulb temperature must be kept below 75° F. (Haldane). The men should not pass from a warm caisson to a cold air-lock and a cold outside world. They should go through a warm lock to a warm room.

Hot, moist atmospheres are very disadvantageous to health and work. If the wet-bulb temperature is high in the caisson, the current of air should be increased or electric fans used to cool the workers. Electric fans have enormously increased the efficiency and health of Europeans in the tropics. An excess of CO_2 in the air-lock, or diver's helmet, during decompression is favourable, as it increases the pulmonary ventilation and the outbreathing of nitrogen. Haldane advises the air-pump to be slackened purposely. There is no harm in breathing 1 or even 2 per cent. of CO_2.

Methods of Decompression.

The safety of compressed-air workers depends on the relation of the period of decompression to that of compression.

The period of the saturation or desaturation of the body with nitrogen depends on the relation between the circulating volume of the blood and the volume (1) of the tissue fluid (2) of the body fat which dissolves the nitrogen—remember the fat dissolves five or six times as much as the tissue fluid. The more often the whole volume of the blood circulates round the body, the quicker will be the saturation or desaturation. The smaller the body, the more often does the volume of blood course round it. A mouse's heart beats six hundred or seven hundred times a minute against a man's seventy (F. Buchanan). The circulation and rate of respiratory exchange are twenty times faster in the mouse. In the case of a man, the smaller man, the leaner and harder the man (less fat and tissue fluid), the quicker will his body saturate and desaturate. The rate of the circulation and percentage of fat vary in different organs. There are parts quickly and parts slowly saturated or desaturated. The joints, tendons, subcutaneous fat, abdominal fat depôts, are relatively slow parts. The white matter of the brain and spinal cord has much fat in it, while the grey matter has little fat and a more active circulation. In the white matter of the spinal cord bubbles commonly form and lead to a stoppage of the circulation there, death of the tissue, and paralysis. Bubbles in the subcutaneous fat, or fat depôts of the belly, may be compared to stones scattered in the fields, and bubbles in the spinal cord to rocks thrown down on the main railway lines of London.

Muscular work increases the circulation and pulmonary ventilation five or six, even ten, times if the work is very hard. In warm, moist caissons the cutaneous vessels are dilated, and the circulation accelerated, and this makes the saturation of the peripheral parts quicker than in the case of the diver, who is surrounded with cool water. The diver also does not work so hard and so long as the caisson worker. Therefore the caisson worker suffers far more from "bends." The diver goes to much greater pressures for short times, and after a quick decompression may suffer from asphyxia, symptoms of paralysis—arising from bubbles in the heart and pulmonary vessels, or in the spinal cord. The caisson worker when decompressed stands quiet, and is subjected to the cooling effect of the expanding air, and this constricts his cutaneous vessels and prevents desaturation of the peripheral parts. The caisson worker ought to be decompressed in an air-lock which is comfortably warmed, and he ought to exercise himself hard in order to keep up the circulation and pulmonary ventilation, and so hasten desaturation.

Haldane thinks that the body of man is about half-saturated in one hour, and about saturated in four hours. Bornstein says six or seven hours are required for saturation of the fat. Greenwood and I found that the urine secreted by the kidney is about saturated after ten minutes' exposure to four atmospheres. About twenty minutes were occupied in reaching this pressure. On decompression of a saturated animal the viscosity of the colloidal blood prevents the formation of bubbles under a certain difference of gas pressure. It is found by experience that it is safe to decompress men in a minute or two from two atmospheres to one. Since the volume of a gas is halved at two atmospheres, made one-fourth at four atmospheres, one-eighth at eight atmospheres, and the volume of a bubble is doubled on lowering the pressure from eight to four, six to three, four to two, or two to one, Haldane concluded it was safe to come rapidly from four to two, six to three, or eight to four atmospheres. The supersaturated tissues then give nitrogen to the blood, and the blood to the lungs, and the nitrogen escapes without bubbling at the half-pressure stage, where a long pause is given. Successive stages may be given when required to secure the desaturation of the body, each stage by producing a safe degree of supersaturation accelerating the outgiving of the dissolved nitrogen. The stage method of decompression initiated by Haldane, and adopted by the Admiralty, has an advantage over the uniform in that it prevents the further, and perhaps dangerous, saturation of the slow parts. Supposing a diver had been for half an hour at six atmospheres pressure; if he were decompressed on the old plan, slowly and uniformly, his fat would become further saturated up to five atmospheres while he was being decompressed from six to five atmospheres. On the other hand, if he is decompressed rapidly from six to three, the further saturation of the fat at pressures above three atmospheres is altogether prevented. The stage method is of value to divers, who go down for short periods and do not work very hard, as it prevents the saturation of slow parts and hastens the period of decompression.

Caisson workers who do four to eight hours' shift are practically saturated; but they, too, are best decompressed by the stage method, because it accelerates the outgiving of the nitrogen by producing a safe degree of supersaturation of the blood. The safety is greatly enhanced if hard muscular work is done during the pauses. This can be effected by having a series of air-locks, and making the men walk, or better, climb, between each. In the East River tunnels this method was tried with good results—(1) +40 to +29 lb. in five minutes; (2) ten minutes walking in +29 lb.; (3) +29 to +12½ lb. in eight minutes; (4) ten minutes walking in +12½ lb.; (5) +12½ to +0 in fifteen minutes. Lengths of tunnel were arranged between locks for walking in. Total time, forty-eight minutes. The Admiralty table enforces ninety-seven minutes for this pressure.

As there were 1·60 per cent. cases of "bends" and no serious ones, the Admiralty time is demonstrated to be unnecessarily long. This is particularly so if ***hard work*** is done during decompression, for the same amount of nitrogen would be expelled in about one-fifth of the time as during rest.

Greenwood and I have tested the stage method on pigs, which are more like men in shape, diet, and habit than goats—the animals used in the investigations conducted for the Admiralty Committee. It appears from our results fairly safe to decompress even fat pigs from six atmospheres to 2⅓ atmospheres in about ten minutes, and then after a pause of 1½ hours from 2⅓ to one atmosphere in twenty minutes. The pigs slept quietly in the warm caisson and never moved, and, being fat, were very unfavourable subjects. One death and no severe case of illness occurred among forty-seven pigs weighing 50 to 100 lb.; one severe and three slight cases among nineteen goats weighing 39 to 57 lb. A similar decompression of fat pigs from seven atmospheres, allowing 105 to 120 minutes interval at 2⅓ atmospheres, gave unfavourable results, seven deaths and one severe case—among twenty-seven pigs weighing 81 to 115 lb. Only one pig out of all showed any symptoms after reaching the stage at 2⅓ atmospheres. At these very high pressures there is great risk unless time enough is given, and plenty of exercise taken during the pause.

For pressures up to four atmospheres the method employed by Mr. Yapp at the East River Tunnel is evidently a very good one. For pressure two to three atmospheres it is an advantage to do work immediately after decompression, supposing work cannot be provided between two air-locks (Bornstein). At the Greenwich Tunnel, now being built, the men climb the shaft, 60 feet high, after decompression, and since I made the suggestion, and the engineer, Mr. E. H. Tabor, carried it out, the number of cases of "bends" has dropped from 1 in 94 to 1 in 240 man-shifts. For higher pressures it would not be safe to take exercise after; it ought to be taken during decompression and the pauses between the stage decompressions. The importance of this cannot be insisted on too much. Exercise during decompression is the simplest means of rendering compressed-air work safe and of keeping the period of decompression of a reasonable length.

The question of the length of shift desirable has been much discussed. Long shifts of eight hours are found to give more illness than shifts of, say, one to two hours. Every practical caisson engineer agrees to that. Divers are decompressed in a few minutes from high pressures (five to six atmospheres) with comparative immunity if they have been down for only a few minutes. Cases of illness occur when they exceed their stay, or after a succession of dives, each of which helps to saturate slow parts and increases the fatigue of the diver. The Admiralty table fixes the period spent at the bottom so as to prevent saturation of "slow" parts and shorten the period of decompression. The descent is hastened for the same reason. It is quite safe to descend to 200 feet in two minutes; slow descents only increase risk by increasing the saturation of the body. In the matter of the caisson workers at the East River Tunnel, two three-hour shifts per diem, with three hours' rest between, gave 1·07 per cent. cases, and one eight-hour shift 0·62 per cent. cases. The men are so far saturated in three hours of hard work that doubling the decompressions is worse than extending the shift to eight hours. As bubbles may persist for a long time in the tissues, and may act as starting points for the formation of other bubbles, it is wise to give long intervals of time between shifts; also in a short interval slow parts may not become desaturated. Haldane has suggested the men should return to a "purgatory" chamber, say at two atmospheres, and eat their dinner and rest there in the mid-period of an eight-hour shift, and again at the end of the shift, when, while waiting for decompression to one atmosphere, they could wash, change their clothes, and have some hot coffee to stimulate the circulation. In any large tunnel works such a chamber could be easily constructed out of a section of the tunnel. This would suffice for stage decompression, and would give excellent results if the men could be persuaded to take exercise in it, or be given oxygen to breathe before decompression to one atmosphere.

The quickest method of desaturating the body is to "wash" the nitrogen out by breathing oxygen for a few minutes before and during decompression. The only question is the safety of this proceeding, for high concentrations of oxygen act as a poison.

Oxygen Poisoning.

(1) I have found that all kinds of animals, worms, snails, flies, spiders, frogs, &c., are instantly convulsed and killed by exposure to fifty atmospheres oxygen. (2) The frog's heart beats, nerve conducts and muscle contracts for some time in fifty atmospheres oxygen, but there is evidence of progressive diminution in functional power; the muscles behave like a fatigued muscle. (3) Mice exposed to ten atmospheres oxygen are thrown into tetanic spasm, and on being decompressed continue to be convulsed by a touch. Bubbles of oxygen are to be then found in the central

nervous system compressing the nerve cells. As the bubbles are oxygen, the cells do not die, and the animals may recover, the oxygen being absorbed by the tissues and the circulation re-established. (4) +3 atmospheres oxygen convulsed animals in thirty to sixty minutes (Bert and Lorrain Smith), and the poisonous effect, depending as it does on the partial pressure of oxygen in the blood, comes on just as soon in larger animals as in small, *e.g.* cats, rats, and mice. (5) Fatal inflammation of the lung is produced by exposure to high partial pressures of oxygen, *e.g.* after twenty-five hours' continuous exposure to +7 atmospheres of air = 170 per cent. atmospheric oxygen (Lorrain Smith). This can be prevented by using nitrogen to dilute the air, and so lowering the partial pressure of oxygen. (6) It is quite safe to breathe one atmosphere oxygen, or five atmospheres air, for three to four hours. The men who wear the Fleuss apparatus for rescue work in mines have breathed it day after day for this period. I have spent much time with Mr. R. H. Davis in perfecting this apparatus on physiological lines, and so have studied particularly the effect of oxygen on man. In very hard work there may be a deficiency of the oxygen supply in the body, and then breathing oxygen helps the working power of the man.

If the body is getting enough oxygen the breathing of it has no effect on the metabolism. The man at rest cannot be fanned into a greater rate of activity by breathing oxygen. Poisonous pressures of oxygen lower the metabolism and diminish the carbonic acid output of animals. Martin Flack and I showed that the breathing of oxygen just before a race may help an athlete, because during his great effort he uses up oxygen quicker than his respiration and circulation can provide it. A shortage of oxygen leads to the production of acid products in the tissues and blood, which causes breathlessness and stiffness of the muscles.

Lactic acid appears in the urine after a short period of hard running (Ruffel). Feldman and I have found that breathing oxygen by means of the Fleuss dress during the run prevents the excretion or lessens the amount of lactic acid excreted. Thus the pressure of oxygen helps the caisson worker to do his work more easily. During decompression the pressure of oxygen is lowered, and this is of no advantage to him.

Bornstein at the Elbe Tunnel works has breathed oxygen (90 to 95 per cent.) for forty-eight minutes at a pressure of three atmospheres. Two other engineers breathed it for thirty minutes. Bornstein freed himself from "bends" by this means. These periods are the outside limits of safety. Bornstein began to have slight convulsive movements.

For every atmosphere the body dissolves nitrogen to about 1 per cent. of its mass—for a 60 kgm. man, say, 600 to 1000 c.c. per atmosphere. Von Schrötter calculates that oxygen plus exercise would turn out 1000 c.c. in five minutes, probably more.

Oxygen can be breathed economically by means of the Fleuss apparatus, which was used so effectively in the last great colliery disaster at Bolton. The apparatus can be put on and oxygen breathed for ten minutes before and during decompression. The breathing-bag must be washed out several times with a current of oxygen, from the emergency valve provided, to accelerate the output of nitrogen.

J. F. Twort and I have investigated the effect of breathing oxygen on the volume of nitrogen dissolved in the urine. Precautions were taken to collect the urine without contact with the atmosphere. About three pints of water were drunk thirty minutes before collection of urine, so that samples could be obtained every seven minutes or so. The samples were pumped out by means of the Gardner and Buckmaster gas-pump, in which there are no taps, and leakage of air is practically nil.

I cite the results of two experiments.

(1) Breathed air at three atmospheres. After fifteen minutes emptied bladder. Sample I. collected seven minutes later at three atmospheres. Decompressed to $1\frac{2}{3}$ atmospheres in three minutes. Sample II. collected six minutes later at $1\frac{2}{3}$ atmospheres. Decompressed to one atmosphere in three minutes. Sample III. collected three minutes later at one atmosphere.

		Nitrogen	Oxygen	Pressure a.m.	Nitrogen calculated (0·85 per atm.)
Sample I.	...	3·054	0·152	3	2·55
,, II.	...	2·859	0·144	$1\frac{2}{3}$	1·416
,, III.	...	1·609	0·081	1	0·85

(2) At three atmospheres for forty-four minutes. Emptied bladder and breathed oxygen for nine minutes, then took Sample I. Decompressed to $1\frac{2}{3}$ atmospheres in two minutes. Took Sample II. four minutes later. Decompressed to one atmosphere in $1\frac{1}{2}$ minutes. Took Sample III. five minutes later.

		Nitrogen	Oxygen	Pressure a.m.	Nitrogen calculated
Sample I.	...	2·091	0·297	3	2·55
,, II.	...	0·8835	0·1985	$1\frac{2}{3}$	1·416
,, III.	...	0·5751	0·0941	1	0·85

The results show that the urine is supersaturated with nitrogen after decompression in the first case, and undersaturated after breathing oxygen in the second case.

The ideal method, then, for safe decompression from high pressure is (1) oxygen breathing for five minutes and rapid decompression to two atmospheres; (2) pause during which oxygen is breathed and exercise taken; (3) rapid decompression to one atmosphere while oxygen breathing and exercise are continued.

The period of decompression can be notably shortened by such means, how far further experiment will show. We want to know, in particular, how the fat of the spinal cord is desaturated under these conditions. The "quick" parts are evidently put right in a few minutes. Further experiments on fat pigs should give the required information.

Recompression.

Recompression is the one method of cure for the illness. Pol and Watelle (1854) recorded the benefit of this. Men with "bends" went back under pressure. A. Smith suggested the use of a recompression chamber at Brooklyn. E. W. Moir instituted it at the Hudson Tunnel. All caisson works are now provided with such. Men at the East River Tunnel works have truly been raised from the dead by its means.

In the frog's web experiment I have observed the bubbles shrink up on recompression. Experiments on animals show that recompression must be applied at once in dangerous cases, before vital parts are killed by the interference with the circulation. "Bends" may be relieved by compression long after they have come on.

Recompression relieved 90 per cent. of the cases at the East River Tunnel, and all but 0·5 per cent. were partly relieved by its means. Oxygen breathing can be employed with advantage in the medical lock. Decompression from the lock must be slow, for some of the bubbles, having run together to form larger ones, only shrink up on recompression, and do not quickly go into solution. These expand again on decompression. J. F. Twort and I have observed this happening, and measured the bubbles under the microscope.

For deep-diving work a recompression chamber should always be at hand. I have contrived a double-chambered diving bell, one chamber open to the sea, the other closed, save for a manhole communicating with the first. The divers after completing their work enter the inner chamber and close the manhole. The bell is raised on deck, and the men decompressed by the stage method. Such a contrivance prevents exposure to cold during, or risk of storm preventing, gradual decompression in the ordinary way by the diver climbing the shotted rope.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—The annual Congregation for the presentation of degrees was held on Friday, October 20. After the deans had presented the graduands in the various faculties, the following honorary degrees were conferred:—*Doctor of Letters:* Prof. Alfred Marshall; *Doctor of Science:* Mr. Arthur Prince Chattock, Prof. Julius Wertheimer, and Sir William Ramsay. The recipients of the science degree were introduced by Prof. Francis, and described as follows:—

Mr. Chattock.—For twenty-one years professor of physics in University College, Bristol, and late Henry Overton Wills professor of physics in this University. A distinguished authority in those realms of physics which he made his own. A teacher who sacrificed himself to his students, and whose wide sympathies and varied knowledge were always at their disposal.

Prof. Wertheimer.—Officier de l'Académie, B.A. and B.Sc. of the University of London, principal of the Merchant Venturers' Technical College, dean of the faculty of engineering in this University. A man who by his energy and conspicuous talent for organisation has made the Merchant Venturers' Technical College one of the leading institutions in the kingdom, and has played no mean part in the formation of this University.

Sir William Ramsay.—K.C.B., Commander of the Crown of Italy, officier de la légion d'Honneur, Ritter of the order Pour le Mérite, D.Sc. of the Universities of Oxford, Cambridge, Dublin, Columbia, Liverpool, and Sheffield; LL.D. of the Universities of Glasgow and Birmingham; M.D. of the Universities of Heidelberg and Jena; Ph.D. of the Universities of Tübingen, Cracow, and Christiania; Nobel prizeman in chemistry (1904); F.R.S.; professor of chemistry in the University of London; and late professor of chemistry and principal of the University College, Bristol. Famous for all time for his discoveries of fundamental importance in physics and chemistry, and for his marvellous realisation of the transmutation of the elements.

Prof. Michael E. Sadler has been appointed Vice-Chancellor of Leeds University, in succession to the late Sir Nathan Bodington.

It is announced in *Science* that the class of 1886 has presented to Harvard University 20,000*l.*, the income of which is to be used for the benefit of the college. From Mr. W. J. Riley, of Boston, the University has received 5000*l.* for the establishment of scholarships in memory of his nephew.

The dissolution of the City Polytechnic in 1907 rendered a new scheme for the management of the Northampton Polytechnic Institute, Clerkenwell, necessary, and this scheme has now been sealed by the Charity Commission. The principal matter of public interest arising out of it is that it gives the governors power to appoint a president of the polytechnic; in accordance with these powers H.R.H. the Duke of Connaught, K.G., has been offered, and has accepted, the new office.

The first issue has appeared of a new educational periodical, published in Calcutta under the title of *The Collegian*. It is described as "an all India journal of university and technical education," and will appear fortnightly, with the object of keeping its readers in touch with the work of the five Indian universities and of higher education generally throughout India. Among a very varied table of contents we find an illustrated description of the College of Agriculture at Sabour, Bengal, by Mr. D. N. Mitra. The detailed information provided about the Indian universities will prove popular among the students in them.

In response to the appeal to raise the sum of 15,000*l.* as a building fund for the Galton Laboratory for National Eugenics, the following sums, amounting to a total of 2260*l.*, have been given, promised, or promised conditionally on the buildings being commenced within two years:—Mr. W. E. Darwin, 500*l.*; Prof. Pearson, F.R.S., and Mrs. Pearson, 500*l.*; Prof. Arthur Schuster, F.R.S., 250*l.*; Mr. E. G. Wheler (first contribution), 250*l.*; the Earl of Rosebery, 100*l.*; Lord Iveagh, 100*l.*; Major Leonard Darwin, 100*l.*; Major E. H. Hills, F.R.S., 100*l.*; Institute of Actuaries, 52*l.* 10*s.*; Mr. C. B. Edgar, 50*l.*; Mr. W. H. Macaulay, 50*l.*; Dr. E. H. J. Schuster, 50*l.*; Mr. Alfred Tyson, 50*l.*; Mr. J. Archer, 25*l.*; Mr. H. R. Beeton, 21*l.*; the Master of Trinity, 10*l.* 10*s.*; Lord Avebury, 10*l.*; total, 2219*l.* An amount of 41*l.* 16*s.* has been received in smaller sums.

The Calcutta correspondent of *The Times* states that the Government of India is understood to be prepared to sanction the scheme of a Mahommedan University provided that the funds actually collected are adequate and that certain changes are made in the draft charter. With regard to finance, the condition laid down is that an annual income of 33,000*l.* must be secured. So far, an income of 21,400*l.* has been obtained. In this sum are included the receipts of Aligarh College, which represent a capitalised value of 446,000*l.* The campaign led by his Highness the Aga Khan has resulted in promises to the amount of 246,000*l.*, which will undoubtedly be realised, though the sum in hand is as yet only 99,000*l.* To the estimated income of 21,400*l.* must be added an annual grant of 6600*l.* which has been promised by the Government of India, leaving an additional income of 5000*l.* to be raised by the Mahommedan community.

The council of the Zoological Society arranged last year with the Education Committee of the London County Council for a series of demonstration lectures to school teachers. The society arranged the courses, provided the lecture-room and lantern, and allowed the teachers free admission to the Zoological Gardens, while the education authority made a grant towards the expenses. The course, which was repeated three times last session to three separate sets of 150 school teachers, consisted of three lectures, illustrated by lantern-slides, and a demonstration in the gardens. This year the number of demonstrations in the gardens is to be larger, and the Education Committee has increased its grant. The first lecture for the present session took place on October 21, and was attended by nearly 150 teachers, while four parties of twenty-five teachers were taken for a demonstration tour in the gardens by the lecturer, Mr. J. L. Bonhote. To suit the convenience of teachers, all the lectures and demonstrations are given on Saturday mornings. The syllabus has been made very simple, and it is devised to cover only such subjects as are likely to interest school children and to be understood by them.

The current issue of *The Oxford and Cambridge Review* contains an article signed "Tu ne cede malis" on "The Education of Study." The conditions of life and work at Oxford and Cambridge are criticised very frankly. At Oxford, the writer says, it is urged "that collegiate life, with all its various activities, is the main thing; that such a life moulds character, and that academic study is a secondary affair." The complexion of the universities is reflected, says the writer, in the life of the nation. "An extraordinary obsession has attacked the minds of most classes of Englishmen. It is to the effect that book-learning of any kind—apart from the three *r*'s and the like—is of very little value." The author knows men "who maintain even violently that anything like academic study is ruinous to all practical efficiency." In another place we are told: "The chief mischief is that the great world has ceased to regard professional eminence as a substantial asset, unless it be accompanied and certified by a display only possible to a man of considerable pecuniary means." The writer's conclusion is "that an educational commission of the most extensive scope is absolutely necessary"; though "our educational system stands in need of nothing more than sensible reform, not of root and branch upheaval."

The arrangements for the Congress of the Universities of the Empire, 1912, are making progress. The Home Universities Committee, consisting of the Vice-Chancellors or other representatives of the universities of the United Kingdom, is engaged in preparing the programme of subjects to be discussed at the congress, and has had before it communications on the matter received from some of the overseas universities. The preliminary Conference of Canadian Universities, held on June 6 in view of the congress, proved a very successful gathering. Seventeen of the nineteen Canadian universities accepted invitations to appoint representatives. Dr. R. D. Roberts, secretary of the congress, was present at the conference on behalf of the London Congress Committee; and we learn from the interesting and suggestive report which he submitted to the committee that the subjects which the Canadian universities regarded as amongst the most important for discussion at the congress are the increase of facilities in the universities of the United Kingdom for post-graduate and research work, and some plan for the interchange of university teachers. It appears that the majority of Canadian post-graduate students go to the American and German universities, and not to the universities of the United Kingdom. Reasons for this are set out in Dr. Roberts's report; and it may be confidently expected that the deliberations of the congress next year will lead to some combined action to remedy this state of things, for it is clearly of supreme importance, both from the university and the imperial points of view, that able students from the King's dominions overseas should be encouraged to pursue their post-graduate studies in the Mother Country.

A copy of the annual report, for the year ended May 31, 1911, of the Rhodesia Scientific Association, has reached us. It contains, among other interesting particulars of the work of the association, the address of the retiring president, Mr. F. P. Mennell, who took education in Rhodesia as his main subject. Dealing with scientific and technical training, the president pointed out that he had exceptional opportunities of coming into contact with the men who desire technical and scientific instruction, and proceeded to propose the following plan. In the first place, he said, a building would have to be hired or erected, which might be known as the Bulawayo Technical Institute. The expenditure of 2000*l.* would probably meet all requirements in the building line, provided, of course, that the convenience of the users was given first consideration and not the fancies of architects. In the next place it would be desirable to engage a man to act as organiser and principal, in addition to teaching one or more subjects. For other teachers it would be necessary to ask the cooperation of the museum, the Geological Survey, the Government mining engineer, and even local professional men. There might thus be secured, without great expense, the services of specialists, who would each conduct a particular course. The feature of the scheme would be the shortness of the courses. Each subject would be limited to a month, every morning and afternoon being devoted during that time to the same subject, until the course was finished. Practical, that is, experimental, work would necessarily be an essential feature of each course. As subjects Mr. Mennell suggested inorganic chemistry, physical geology, agricultural chemistry and geology, determinative mineralogy, theory of ore deposits, principles of sampling and opening up mines, metallurgy of gold. Possibly, in addition, it might be found practicable to teach gold assaying and simple methods of surveying. It need scarcely be said that most of these subjects could not be effectively taught in so short a period as a month. A great deal, however, could be done in that time. In the event of more extended courses being established, the president continued, Rhodesia would only be competing unavailingly with Johannesburg, whereas the people it is desired to attract are those who cannot afford either the time or the money to go there.

SOCIETIES AND ACADEMIES.

London.

Institution of Mining and Metallurgy, October 19.—Mr. H. Livingstone Sulman, president, in the chair.—H. Standish **Ball**: The economics of tube milling. The investigation, of which this paper is a report, was undertaken by the author at the McGill University, Montreal, for the purpose of determining the most efficient working conditions of the tube-mill on metal-bearing ores. An experimental tube-mill was constructed, with all necessary accessories, and a series of test runs was made under various conditions of feed, moisture, pebble load, and speed, the system adopted being that in each series of tests one of the above factors was varied whilst the others were maintained as constants. Taking the experimental mill as a standard, the result of the tests was to establish certain conditions for each of the four factors mentioned as those most conducive to efficiency; and the author believes that there is a possibility of estimating from the curves obtained from the different tests the probable results that would be derived from running the mill under different conditions. He deduces from this the rather startling theory that in any mill it would be possible by a similar series of tests to obtain the necessary information for running it to the best advantage. Among other results of his experiments he was able to ascertain the duration of time required by a mill to assume a uniform condition following a change of adjustment of its various component factors, and to test the efficiency of the mill during the transition periods. Having ascertained by tests the several conditions under which the mill worked at its best, a trial was made during which the critical factors were all complied with, and the resultant mechanical efficiency was found to show an increase of 14 per cent. above all previous tests, thus seeming to bear out the utility and value of experimental work in determining the proper conditions of working.—Eugene **Coste**: Fallacies in the theory of the organic origin of petroleum. The author sets out to show that the supporters of the organic theory founded their arguments on erroneous premises, and ignore the obvious facts presented by the petroleum occurrences and deposits, which point to a volcanic origin In proof of his own theory he directs attention to the abundance of hydrocarbon emanations noted in connection with volcanic phenomena, as showing that the sources of carbon are not confined to the organic kingdom alone. The conclusion at which he arrives is that the constant recurrence of hydrocarbons in volcanic and igneous rocks, in volcanic emanations, in metallic and other veins, in meteorites, in comets and other stellar bodies, clearly demonstrates that petroleums are not organic, as if they were their distribution could not possibly resemble the actual occurrences which are met with. The petroleum deposits are not everywhere associated with rocks of a particular age, but are found in strata of all ages, and only along some of the tectonic disturbances; where there are no such disturbances the strata are barren. These occurrences are therefore, he claims, due to dynamic disturbances accompanied by magmatic emanations from the interior, which must be held to be of solfataric volcanic nature, and unlike anything else known to be to-day in the active process of formation in nature.

Paris.

Academy of Sciences, October 9.—M. Lippmann in the chair.—L. **Mangin**: *Peridiniopsis asymetrica* and *Peridinium Paulseni.* These two species are currently known under the name of *Diplopsalis lenticula.* By the use of a boiling solution of 5 per cent. potash the nitrogen compounds are removed, and the structure can be more easily made out. The supplemental apical plate has either been missed by previous investigators or else its presence has been considered as an anomaly. This plate, however, is always present, and indicates a separate genus.—A. **Laveran**: Are trypanosomes latent in their vertebrate hosts? An account of some experiments undertaken with a view to verify facts put forward by Salvin, Moore and Breinl, Fantham, and Hindle. The conclusion is drawn that for the trypanosomes studied, especially *T. gambiense,* there is no non-flagellated stage of evolution in the vertebrate organism, and that the elements described under the name of latent bodies correspond to different stages of involution of the trypanosomes.—G. A. **Tikhoff**: The variable star of the Pleiades. Observations for the last sixteen years of the magnitude of this star have been plotted as a curve, magnitudes as ordinates, and the time as abscissæ. The period between a maximum and minimum is shown to be 565 days, the last maximum being on January 10, 1911.—P. **Chofardet**: Observations of the Quénisset comet (1911*f*) made at the Observatory of Besançon with the 33-cm. bent equatorial. Positions are given for September 26 and 29. The comet was estimated as of the eighth magnitude, with a round head 3′ in diameter. There is no well-defined nucleus, and the tail is absent.—Paul **Lévy**: A generalisation of the theorems of Picard, Landau, and Schottky.—A. **Blondel**: The reception of periodic trains of damped waves in radio-telegraphy.—F. **Croze**: The spectrum of the negative pole of oxygen. The group of bands shown in Sturbing's photograph cannot be represented by the ordinary formula for band spectra, and the number is too small to establish a regularity with certainty. The author has discovered a new less refrangible band, and shows that the differences are analogous to the nitrogen bands.—Félix **Robin**: Pitch in alloys and its variation with temperature. In steel tuning-forks chromium raises the pitch, whilst nickel lowers it. For a nickel steel containing 30 per cent. of nickel the pitch increases with rise of temperature up to 90° C. Four alloys are suggested as suitable for standard tuning-forks, the composition being such that the pitch is practically independent of the temperature.—Mlle. E. **Feytis**: The magnetic *rôle* of water in the constitution of some solid hydrates. The additive law cannot be considered as applicable with certainty when dealing with salt molecules containing strongly electropositive metals.—G. **Charpy** and S. **Bonnerot**: The cementation of iron by solid carbon. From their experiments, published in January, 1910, the authors concluded that solid carbon could not cause cementation in iron in a vacuum; since then, new experiments by M. Weyl have led to the opposite conclusion. The results of fresh experiments are now given, and it is concluded that the cementation of solid iron by carbon at about 950° C. is absolutely *nil* in the absence of gases capable of reacting on the carbon and metal.—Robert **Pers**: An equilibrium between chloropentaminecobaltic chloride and aquopentaminecobaltic chloride in aqueous solution.—Paul **Bary** and L. **Weydert**: The apparently reversible character of the vulcanisation reaction between indiarubber and sulphur. Reasons are put forward for the view that the vulcanisation of indiarubber by sulphur is accompanied by a process of depolymerisation.—Etienne **Boismenu**: The hypobromous amides. The reaction between hypobromous acid and amides has been found to take place according to the equation

$$R—CO—NH_2+BrOH=R—CO—NH—Br+H_2O$$

in the cases of the amides of propionic, benzoic, and formic acids. The bromo-acetanilide could not be isolated owing to its instability.—A. **Behal** and A. **Detœuf**: A new derivative of urea, monochlorurea. If chlorine is passed over urea at the ordinary temperature in the proportion of one atom of chlorine to one molecule of urea, a mass is obtained which gives reactions corresponding to a mixture of monochlorurea and urea hydrochloride in equal molecules, but these two substances could not be separated by organic solvents. By modifying the conditions of the experiment, the authors have been able to isolate pure monochlorurea and to study its reactions.—P. **Gaubert**: Helicoidal structures.—R. **Souèges**: The development of the embryo in *Mysorus minimus*. For demonstrating how the first cells in a dicotyledon are formed, *M. minimus* is a better example than *Capsella Bursa-pastoris* or any other Crucifer.—C. L. **Gatin**: Experimental reproduction of the effects of the tarring of roads on the neighbouring vegetation.—Raphaël **Dubois**: New researches on the physiological light in *Pholas dactylus*. The light is the result of an indirect oxidation of an albuminoid substance (luciferine) by a peroxydase (luciferase).—G. **Faroy**: Proof of the treponeme in tertiary syphilis of the kidney with amyloid degenerescence.—Foveau **de Courmelles**: The identification of charred bodies by the X-rays. Peculiarities of the bone structure could lead to the identification of bodies so burnt as to be otherwise unrecognisable.—Ch. **Gravier**: The polychætal annelids collected by the second French Antarctic Expedition (1908–1910).—Ph. **Négris**: The importance of the Eocene in eastern Greece and the discovery of the Trias.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 26.

THE CONCRETE INSTITUTE, at 8.—Fire-proofing: R. L. Humphrey.

FRIDAY, OCTOBER 27.

PHYSICAL SOCIETY, at 5.—Further Observations on the After-glow o Electric Discharge and Kindred Phenomena: Hon. R. J. Strutt, F.R.S —Homogeneous Fluorescent X-radiation of a Second Series: Prof. C. G Barkla and J. Nicol.

SATURDAY, OCTOBER 28.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford) at 6.—The Natural History of British Fresh-water Leeches, with Notes on their Occurrence in Essex: Henry Whitehead.—On the Remains of Vertebrate Animals found in recent excavations at Rayleigh Castle, Essex: Martin A. C. Hinton.—Report of Club's Delegate at Portsmouth Meeting of British Association: W. Whitaker, F.R.S., and D. J. Scourfield.

MONDAY, OCTOBER 30.

ARISTOTELIAN SOCIETY, at 8.—The Relations of Universals and Particulars: Hon. Bertrand Russell, F.R.S.

WEDNESDAY, NOVEMBER 1.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Notes on Shrewsbury and Knapp's Process for Estimating Cocoanut Oil: H. S. Shrewsbury and A. W. Knapp.—Note on a Counterfeit Gold Coin: H. S. Shrewsbury.—Note on the Examination of Finnish Turpentine: L. Myddelton Nash.—Note on the Approximate Estimation of Starch by Iodine: Lester Reed.—Note on the Gravimetric Estimation of Phosphorus in Milk: E. H. Miller.—Kobert's Reagent as a Test for Salicylic Acid: J. McCrae.—Precipitation of Nickel Compounds and Preparation of Spongy Nickel: W. H. Low.

ENTOMOLOGICAL SOCIETY, at 8.—The Effect of Temperature on Animal (especially Insect) Life: Dr. A. G. Butler.—Parthenogenesis in Worker Ants: W. C. Crawley.

THURSDAY, NOVEMBER 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers*—Colour Blindness and the Trichromatic Theory of Colour Vision. Part III. Incomplete Colour Blindness: Sir W. de W. Abney, K.C.B., F.R.S.—Note on the Iridescent Colours of Birds and Insects: A. Mallock, F.R.S.—The Behaviour of the Infusorian Micronucleus in Regeneration: K. R. Lewin.—An Inquiry into the Influence of the Constituents of a Bacterial Emulsion on the Opsonic Index: A. F. Hayden and W. P. Morgan.—The Morphology of *Trypanosoma gambiense* (Dutton and Todd): Colonel Sir David Bruce, C.B., F.R.S.—Preliminary Report upon the Injection of Rabbits with Protein-free (tuberculo-) Antigen and Antigen-Serum Mixtures; Factors in the Interpretation of the Inhibitive and Fixation Serum Reactions in Pulmonary Tuberculosis: A. H. Caulfeild.

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