NATURE

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

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THURSDAY, MAY 13, 1915.

PHYSICAL CONSTANTS.

Société Française de Physique, Recueil de Constantes Physiques. By Prof. H. Abraham and Prof. P. Sacerdote. Pp. xvi+753. (Paris: Gauthier-Villars, 1913.) Price 50 francs.

THIS large and handsome volume of 753 pages is a collection of physical constants compiled under the auspices of the French Physical Society by Profs. Abraham and Sacerdote, and printed in the excellent style with which one is familiar in the publications of Messrs. Gauthier-Villars.

Following the custom of the more recent editions of Landolt and Börnstein's Tables and the new Annual International Tables of Constants, the work has been divided among a number of specialists, and each page bears the name of the individual responsible for it.

The system adopted has particular advantage in a volume planned with the idea of giving in general only one value for each constant. Reference is usually given to the name of the authority cited and the year of publication, but the source of the particular information is not specified. A useful explanatory paragraph with formulæ generally precedes each table.

A novelty is the introduction of a large number of curves. For example, the curves of the physical properties of gases given by Amagat impart at a glance an amount of information which would have required a table of many columns. Some very fine reproductions of spectra are given, including a large-scale reproduction of the iron spectrum, which should be extremely useful.

An examination of the book and frequent reference to it for constants required in actual work has revealed only few errors, and on the whole the work of the compilers appears to have been well done and the subject matter judiciously chosen.

Among the more interesting novelties are the useful sections devoted to wireless telegraphy and to physical measuring instruments, and no one could have been found to write with more authority on alloys than M. Le Chatelier.

Some eccentricities appear in the initial table on units; few physicists are familiar with such terms as "volume massique" and "masse volumique," "degré carré," and "steradian."

In the table of the specific heat of water the results of nine different observers are given, in most cases to four decimal places. But the "valeurs combinées" are given to *five* places, although examination of the individual values shows large discrepancies in the third decimal. It is much better to avoid in a case of this kind a fallacious air of precision, and it would have been wiser to have followed the example of Commandant Defforges, the well-known authority on pendulum observations, who told an eminent physicist with whom he was discussing his work:—

"Each year, as I know a little more of the difficulties, I suppress a decimal place in my results."

A good feature of the index of organic bodies is that in many cases the common name of a substance is given as well as its other names, perhaps only adopted by the chemists during a period of some passing fashion. For example, benzophenone is to be found in the index, as well as its synonyms, diphenylmethanone, diphenylketone, and benzoylbenzene. On the other hand, formaldehyde is *not* to be found, although four other names of this body appear in the index.

It is, however, surprising to find repeated the old familiar error, the confusion of benz*ine* and benz*ene*, words which in no language mean the same thing, although in some their pronunciation is unfortunately identical.

In some cases almost too much information is given. Thus, for example, the work of Tammann and his associates on the influence of pressure on the melting point of a large number of substances is quoted in detail, while practically nothing is to be found on the even more important effect of pressure on the boiling-point, excepting for a few organic bodies. For dp/dt for sulphur vapour is given Regnault's old value, 0·82° per mm., now known to be considerably too low.

Perusal of a work of this magnitude is suggestive in showing how great is our ignorance in many important branches of knowledge, where it might have been imagined much more precise and accurate data would have been to hand. A good example is the subject of thermal radiation, transparency, etc., where we still depend on Leslie, Rumford, Melloni, and other pioneer workers, who showed the way, where comparatively few have followed to repeat their work with modern appliances.

J. A. HARKER.

THE PRESERVATION OF WILD LIFE IN AMERICA.

Wild Life Conservation in Theory and Practice. By Dr. W. T. Hornaday. Pp. vi+240. (New Haven: Yale University Press; London: Oxford University Press, 1914.) Price 6*s.* 6*d.* net.

NORTH AMERICA, when first opened up by Europeans, possessed a big-game fauna which, although poor in species, in point of numbers was equalled only by that of southern and

central Africa; and it was likewise the home of an extensive and varied fauna of game and other edible birds. To this abundance of wild life is attributable the comparative facility with which the country was explored and settled; but no sooner was the settlement well advanced than ruthless slaughter led to the more or less complete extermination of some species, like the bison and the carrier-pigeon, and a vast reduction in the numbers of others, such as the prongbuck and bighorn. Fashion, sport, and other factors led, later on, to equal havoc among birds of many kinds.

Having permitted all this to come to pass, the country is now gradually waking up to the loss it has sustained, and to the remedial measures still possible in order to ensure the preservation of at least a remnant of the ancient superfluity of life. In this crusade Dr. Hornaday has for many years been a leader, and in the volume now before us he reviews what has been done and what still remains to be accomplished in a manner worthy of all commendation.

So urgent, however, is the case that the author calls upon all biological workers to abandon such comparatively unimportant matters as the description of species and races, the protective coloration of eggs, etc., and to devote all their energies to the cause of protecting and re-habilitating their country's fauna, not only as a food-supply, but, in the case of insectivorous birds, as a protection against the ravages of insect-foes, which are specially severe in America.

In his opening chapter—on the value of wild life—Dr. Hornaday enunciates the axiom that no species of wild land animal can long withstand systematic hunting for commercial purposes, as witness the destruction of the millions of the southern bison-herd within four years. He also points out that when a species has become reduced below a certain number it loses all recuperative power, and, like the heath-hen, fails to respond to protection. Instant action is, therefore, imperative in order to save the present remnant of the game-fauna, which is estimated to be only 2 per cent. of its former numbers. For this purpose "bag"-limitations have proved practically useless; and the conversion of national forests into reserves where shooting shall be absolutely prohibited, is a *sine qua non* (p. 49).

The period from 1885 to 1900 saw the great boom in the plumage-trade, to check which the Audubon Societies were organised; other agencies, which in many cases are proving victorious, came into action soon after; but the greatest hope for ultimate salvation is the federal law of 1913 for the protection of migratory species, which, by bringing recalcitrant States into line, saved the situation. Lastly came what it is hoped will prove the winning card in the shape of the Feather Bill. R. L.

FOUR DIMENSIONS.

Geometry of Four Dimensions. By Prof. H. P. Manning. Pp. ix+348. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

PERHAPS the main interest of this work is that it treats the subject in a way that is comparatively new, and one that is likely enough to be generally adopted. Until quite recently, most works on hypergeometry might be roughly divided into three classes: popular or semi-popular outlines, which, however stimulating or suggestive, have little or no scientific value; frankly analytical disquisitions, such as those of Riemann, etc.; and works which, although couched in geometrical language, give the impression of being, so to speak, translations of previous analytical demonstrations. It must be admitted, of course, that some authors (such as Segre) have obtained new and valuable results for surfaces in three dimensions by considering them as sections of hyper-surfaces, and have pursued other four-dimensional researches in a way which has much more the aspect of being purely geometrical. But since it is a psychological fact that so far we have no true intuition of four-dimensional space, the inference seems to be that these authors have become so familiar with the analytical arguments underlying their theorems that they pass without an effort to the corresponding geometrical form of statement; much in the same way as dualisation of a projective theorem becomes almost mechanical after sufficient practice.

The method of the present work may be described as a logical induction based upon explicit geometrical axioms about strictly geometrical indefinables. The primary element is the point; the primary undefined relation is that of a point P being collinear with a given segment AB. From this the definition and properties of a straight line are deduced; thence we proceed to the definition of a triangle; and from this, with the help of Pasch's axiom (a line meeting one side of a triangle and another side produced meets the third side), we arrive at the definition and properties of the plane.

Assuming, now, that after reaching a plane field of points there is at least one point not belonging to that field, we can construct a tetrahedron, and, by arguments strictly analogous to those employed before, arrive at a three-dimen-

sional space (S_3), which is determined by any four of its points which are not coplanar. There is no logical reason why we should not assume the existence of at least one point which does not belong to S_3; if we do so, we are able, by similar arguments, to show that there will be a space S_4, containing S_3, which is determined by any five of its points which are *independent;* that is to say, which do not belong to the same three-dimensional field.

The important thing to notice here is that the argument is of such a kind that it does not appeal to intuition at all. It is true that by drawing figures, or making models, we can provide images which help us to see that for an S_1, S_2, or S_3 our assumptions are not self-contradictory—or rather to give us an irrational conviction that things are so; for, of course, nothing but a formal proof can demonstrate the consistency or inconsistency of a set of formal propositions, such as we are ultimately dealing with here.

When the reader has reached this point, he will see that we can define and investigate a sequence of spaces:—

$$S_1, S_2, S_3, \ldots S_n, \ldots$$

(each being a field of points) on the assumption that when we have reached a space S_n there is at least one point which does not belong to it. A space S_n is determined by $(n+1)$ independent points; namely, such as do not belong to one and the same S_{n-1}.

The author does not go further than the S_4. After establishing its (logical) existence, he proceeds to discuss perpendicularity and angles; symmetry, order, and motion; hyper-surfaces and polyhedra; the theory of parallels; and that of volume-measurement. Finally, there is a chapter on the regular "polyhedroids" (hyperpolyhedra) in the S_4.

There are many interesting details and illustrations; we may refer to one of these, as it shows very well the way in which we are brought to a halt in trying to make actual images of things in the S_4. If, in an S_2, we draw a square, then a square on each of its sides, and finally a square on one of the outermost sides (so as to make a Latin cross) we can see how to fold the squares about common edges until they form the faces of a cube in our S_3. Suppose, now, that in our S_3 we draw a cube; then a cube on each of its faces; and finally a cube on one of the outermost faces of the last. If we could get this solid into an S_4, we could "fold" the eight cubes about adjacent faces so as to form the boundaries of a hypercube. Until we can "see" how to do this, we have no proper intuition of an S_4, such as we have of the lower spaces. G. B. M.

THREE BOTANICAL BOOKS.

(1) *Mikrographie des Holzes der auf Java vorkommenden Baumarten. Vierte Lieferung.* By Dr. J. W. Moll and H. H. Janssonius. Pp. 336. (Leiden: E. J. Brill, 1914.)

(2) *Practical Field Botany.* By A. R. Horwood. Pp. xv+193. (London: C. Griffin and Co., Ltd., 1914.) Price 5*s.* net.

(3) *All About Leaves.* By the late F. G. Heath. Pp. ix+228. (London: Williams and Norgate, 1914.) Price 4*s.* 6*d.* net.

(1) IN this, the fourth instalment of his work on the intimate structure of the wood of Javan trees, the author deals with the families Connaraceæ, Leguminosæ, Rosaceæ, Saxifrageæ, Hamamelideæ, and Rhizophoreæ. The Leguminosæ occupy more than half the volume. In this family 118 specimens were examined, representing forty-nine species and four varieties contained in twenty-six genera. Under the heading of each family is a list of the literature in chronological order, followed by an enumeration of the species and varieties examined by the author. A general review of the gross and minute anatomy of the family as represented by the forms studied is then given, and the bearing of the results on the generally accepted sub-division of the family is discussed. These are, in the main, in conformity with the sub-division based on floral structure, but it is worthy of note that in Rosaceæ the differences between the groups are greater than is usually the case in a single family, and suggest the recognition as distinct families of the Amygdalaceæ, Chrysobalanaceæ, and Pomaceæ. A key for determining the species by means of the wood-structure is also given. Then follows a detailed description of each species or variety; first the general topography, which is sometimes illustrated by figures, and then an elaborate description of the various elements—wood-vessels, libriform fibres, wood-parenchyma, medullary rays, etc. The account includes measurements and the behaviour of the various elements to reagents. It is to be regretted that the author did not include photomicrographic reproductions of his sections; the few figures which are given are poor and show no detail.

(2) The title of Mr. Horwood's book is somewhat misleading. The book contains much useful information on the practical study of plants in the field, but also much extraneous matter often set down in a loose and desultory manner. The impression formed by the reader is that the author is a man of great industry and some knowledge, but does not realise his limitations. The book, if judiciously pruned and edited, would make a useful little volume. The author's intention is

"to explain and set forth the principles by which the ecologist should be guided, and the apparatus and plan to be adopted to enable him or her to work upon sound and approved lines." But the directions or suggestions will often lead to bewilderment; for instance, the section on pp. 4–6, entitled "What to Study," contains a curious medley of suggestions from the study of the form and size of pollen-grains to the procuring of "fruits and berries of foliage" (*sic*) for decoration at Christmas. On the other hand, the same chapter contains a useful section on flower-photography. Chapter ii., on methods of collecting, preserving, mounting, and storing plants for herbaria, contains much that is helpful, though the student will find puzzling matter in the section on "the arrangement to be adopted in the herbarium"; among other things the author suggests the preparation of "a printed list of all the species published since the year 1895 when the 'Index Kewensis' and Durand's 'Appendix' brought things up to date," thus ignoring the three supplements of the "Index Kewensis" which carry us on to the end of 1910.

A great part of chapter iii., which has the tremendous title, "The necessity for encouraging the study of botany on ecological lines, by the popularisation of pure life-histories of plants, through nature study, museums, scientific societies, and other associations, and in the university," might well have been omitted; much of it consists of extracts from the addresses or writings of well-known botanists. The next chapter, on the study of the life-history of a plant, would have been more helpful if in the brief paragraphs on the various divisions, such, for instance, those on "plants and fungi and insect-pests" or "names of wild plants" reference had been given to a good standard work on the subject. The last chapter (v.), "An outline of plant formations," is the best; it includes a brief description of various plant-formations and lists of the species which occur in them.

(3) The little book on "leaves" contains eighty photographs, mostly of British wild plants, which on the whole are good. They were specially prepared for the work, but were not seen by the author owing to his death in 1913. The text is in the style with which readers of the late Francis George Heath's botanical works are familiar. One example must suffice. Of the seed we read, "A created organism of wonderful and infinite skill confronts our marvelling sense in the remotest confines of the great vegetable world—so that we cannot begin at the beginning because we cannot comprehend the beginning! Power—unquestionable—hovers, so to speak, undiscernible in the tiny seed."

OUR BOOKSHELF.

The Golden Bough. A Study in Magic and Religion. By Sir J. G. Frazer. Vol. xii. Bibliography and General Index. Pp. vii + 536. (London: Macmillan and Co., Ltd., 1915.) Price 20*s.* net.

No book has ever been written which contains so large a mass of facts as "The Golden Bough." Nor has any book had its data more thoroughly documented. The bibliography and index, forming the twelfth and final volume of the work, fill 536 octavo pages. The index, 392 pages, is fuller than the indices to the separate volumes. Every author knows the labour of cross-references; a simple instance here is "propitiation of vermin by farmers," involving three entries. There are cases of overdoing, a good fault in an index, *e.g.* "*Nat*, spirit, in Burma, ii. 46." "*Nat* superstition in Burma, ix. 90 n[1]." "*Nats*, spirits in Burma, iii. 90; ix. 175 *sq.*; propitiation of, ix. 96." Here a distinction is actually drawn between a singular and a plural. Technical generic terms in foreign languages are, like botanical and zoological terms, etc., printed in italics. But why "Oschophoria," yet "*Aiora*," both Greek feasts; and "Farwardajan," yet "*Sada*," both Persian feasts; also "Ogboni" and "Belli-Paaro," African secret societies, yet "*Ndembo*" and "*Hametzes*," also secret societies? But these are minor inconsistencies in a monumental index.

The bibliography comprises probably six thousand books, including serial publications and dictionaries. The curious may find instructive items, *e.g.* Maeletius (Maletius, Meletius, Menecius, Ian Malecki), who, by the way, wrote on the religion of the Borussians (the present-day Prussians). Many periodicals, *e.g.* *L'Année Sociologique* and *L'Anthropologie*, have not their year of institution, nor, what is far more important, their place of publication attached. How are "readers who desire to have further information," to find "*Fasciculi Malagenses, Anthropology*," or "Dinkard, a Pahlavi work"?

The distribution of anthropological research among the civilised nations may be well estimated from this bibliography. England, America, and Holland are prominent; Germany has done much, so has France. The native authorities on uncivilised peoples are an interesting addition.

A. E. CRAWLEY.

The Plateau Peoples of South America. By A. A. Adams. Pp. 134. (London: G. Routledge and Sons, Ltd., 1915.) Price 3*s.* 6*d.* net.

THE people discussed in this monograph are those inhabiting the South American plateau within the boundaries of Bolivia, Peru, and Ecuador. Bolivia, however, seems to be more closely associated with the past history of the plateau than either of the other republics. Its government is largely drawn from the plateau population, and its general culture is more clearly influenced by the plateau than that of Peru, which looks to Europe for light and guidance. The writer finds in this upland race a condition of progressive degeneration. The people who occupied the country in what may be

called prehistoric times were skilled in stone-working, as is shown by the great megalithic ruins at Tiahuanaca, described by Sir Clements Markham in his book, "The Incas of Peru." Since the building of this city, geological changes seem to have been in action which caused the elevation of the plateau and the shrinkage of the body of water now known as Lake Titicaca.

These changes brought about the present conditions: a very dry atmosphere, with a small percentage of oxygen and a high range of temperature, inducing nervousness and mental instability, a lack of forethought and industry, an overweening contempt of foreigners, and a perfervid patriotism. Many physiological facts indicate this retrogression, resulting in administrative incapacity, and neglect of regularised education. The poorness of the food supply, ill-cooked potatoes and maize-flour cakes, promotes physical degeneration and leads to over-indulgence in stimulants. The writer takes, perhaps, too gloomy a view of a people whom he dislikes and despises, but he appears to write with adequate knowledge, and his monograph, if his conclusions be accepted, furnishes a good example of the action of an unfavourable environment upon a race exposed to its influence.

A Pilgrim's Scrip. By R. Campbell Thompson. Pp. xii+345. (London: John Lane, 1914.) Price 12*s.* 6*d.* net.

THESE slight, discursive sketches of the life of a wandering archæologist in the Nearer East are interesting and instructive. The studied archaism of the style, a trick which may have been learned from Mr. Doughty's famous "Travels in Arabia Deserta," becomes, after a time, a little monotonous, but it gives a piquant flavour to his accounts of eastern life and character. The writer is one of the school of scholarly antiquaries, trained by the British Museum, who, in spite of many hardships and the necessity of making scanty funds go a very long way, have done noble service in adding to our national collections.

Mr. Campbell Thompson's experience has given him a considerable insight into the back of the oriental mind, and his hints for dealing with these races and conducting excavations will be serviceable to those who may follow his tracks. His wanderings have extended widely: Mosul, Behistun, the Sinaitic Peninsula, the Sudan, Angora, and Carchemish, are some of the stages. Perhaps the most interesting episode is his excursion, in company with Mr. L. W. King, to make a fresh copy of the famous inscription of Darius at Behistun, the riddle of which was solved by the genius of Sir H. Rawlinson. Swung from cables suspended over the precipice the explorers collated Rawlinson's copies, which proved to be wonderfully accurate, and succeeded in photographing, from a five-foot range, the splendid head of the warrior king—a fine piece of work told modestly and clearly.

The book is well illustrated by photographs and, which is unusual in popular works of travel, is provided with an excellent index.

Morale Fondée sur les Lois de la Nature. By M. Deshumbert. Cinquième et Sixième Mille. Pp. 191. (London: Watts and Co., n.d.)

THE Comité International de Propagande pour la Pratique de la Morale fondée sur les Lois de la Nature has representatives in eighteen countries. Its Bureau Central is at Dewhurst, Dunheved Road West, Thornton Heath, England. It issues a propagandist volume on the subject of a natural morality, written by the secretary, M. Deshumbert, which has been translated into eight languages. Much has been written on morality "according to nature," since the Stoics invented the idea, but this book, partly because the author understands both physiology and biology, has a freshness of appeal. "Good is all that contributes to the conservation and increase of life . . ." by co-operation and mutual aid of individuals each of whom is thus aided towards complete self-realisation. Evil is all that diminishes life. The end of Nature is life and more life.

These and connected axioms are well illustrated by examples of anti-natural human superstition and of the importance in the animal world of intellectual and moral qualities. The way in which, *e.g.* the tiger depends for existence upon observation, judgment, patience, self-control, decision, and perseverance, is quite a fresh object-lesson. A collection of practical rules of personal hygiene and a detailed list of physiological functions are useful, and might form the nucleus of a modern scheme of individual morality. Some quotations from J. Payot are interesting here. A set of parallels between the intelligence of nature and of man is interesting, and might be augmented. "Man in many cases is inferior to nature," but this simply points the truth that man is part of nature.

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.*]

Ultra-Violet Excitation of the D Line of Sodium.

IT is well known that the D line of sodium is the first member of a series of lines, the other members being in the ultra-violet region of the spectrum. It is known also from the investigations of R. W. Wood that sodium vapour at a moderate temperature illuminated by D light gives rise to a secondary emission of D light. This secondary emission is appropriately called by him resonance radiation. It has been further investigated by Dunoyer.

The first ultra-violet line of the series is situated at wave-length 3303. It is very probable for a number of reasons that this or any other line of the series would give rise to resonance radiation, though I do not know of any experiment directly establishing the fact.

A more doubtful question is whether stimulation by the line 3303 would give rise to D light. The question is not new. It has been proposed by Prof. Wood, and he has looked for the effect, but without success. The matter seemed important enough, how-

ever, to justify a fresh effort, and within the last few days I have been able to get the effect as satisfactorily as could be wished.

The chief essential is a source giving a sharp line of great intensity at λ 3303. This was found in a sodium vapour lamp in quartz analogous to the mercury lamps in general use. Details of the construction and manipulation of these sodium lamps will be published later. The visible light from such a lamp was filtered out by means of a screen consisting of cobalt-blue uviol glass, combined with nitrosodimethylaniline. The light which came through was photographed with a quartz spectrograph, and was found to consist of λ 3303 exclusively.

This radiation was concentrated by means of a quartz lens on a quartz bulb containing some sodium. The bulb was made nearly red-hot with a bunsen burner, which was then extinguished. A patch of luminosity could be seen on the wall of the bulb when the ultra-violet beam fell upon it. As the bulb cooled and the vapour pressure of the sodium diminished, this patch of light gradually expanded, and filled the entire bulb; it then faded away, and had disappeared when the bulb was cold. This behaviour is exactly the same as is seen when D light is excited by the incidence of D light, and although in the present case the light is much fainter, the conditions of observation are in some respects more favourable, for there is no disturbance from visible light scattered or reflected by the walls of the vessel.

Critics of this experiment will naturally concentrate their attention on two questions:—

(1) Was the light observed really due to ultra-violet excitation?

(2) Was it of the same wave-length as the D line?

As regards (1), a sheet of plate-glass 1·2 cm. thick was interposed between the source and the bulb. The excited light was completely extinguished.

As regards (2) the light was rather below the intensity which would easily allow of direct spectroscopic examination, though with a little further improvement of the conditions it might be made strong enough. I have, however, proved it to be of approximately this wave-length by absorption methods. The luminosity was seen undiminished through a thick cell containing potassium bichromate solution, held before the eyes. It was absolutely invisible through a cell containing praseodymium nitrate. Thus the wave-length must lie in the region from λ 5820 to λ 6020, for this is the only region transmitted by bichromate and absorbed by praseodymium. The D line at λ 5890 lies in this narrow region, and I think, therefore, that there is no reasonable doubt that the emission does consist of D light. Discussion of the theoretical bearing of this result is deferred.

R. J. STRUTT.

Imperial College, South Kensington, May 8.

The Green Flash.

MANY descriptions of the green flash have been published in letters to NATURE and elsewhere, but I do not remember to have seen a satisfactory explanation of this curious phenomenon. Atmospheric dispersion is invoked, but this does not explain the absence of the red end of the spectrum. My observations agree in every particular with those described by Mr. Whitmell in NATURE of March 11, p. 35. At sea I have observed a violet or blue tint occasionally, and on one occasion a red flash as the lower limb of the sun emerged from a cloud into a clear space very near the horizon.

Normal atmospheric dispersion will, of course, produce a red fringe to the sun's lower limb, and a blue fringe at the upper limb, as may be seen at any time with a telescope free from secondary colour when the sun is as high as ten or fifteen degrees above the horizon. When, however, a point of sunlight only is visible, the rest of the disc being hidden beneath the horizon, atmospheric dispersion, if it could be perceived with unaided vision, should produce a complete vertical spectrum from blue to red, as in the case of stars when near the horizon. The red end of this spectrum should be most evident, since these rays are least absorbed. In the flash, however, the red is completely suppressed, and the vivid green which is obvious to the naked eye can only be seen at very low horizons. Moreover, it is not always seen, as Mr. Whitmell remarks, when the conditions seem otherwise favourable.

It seems to me very probable that the phenomenon is in some way connected with the abnormal conditions which at sea produce mirage effects. The layer of dense air in contact with the sea might produce total reflection for solar rays refracted from below the horizon, but the critical angle of reflection will depend on wave-length, and it is possible under certain conditions that the green rays may be totally reflected whilst the red are refracted.

I have one more observation to add to those described by Mr. Whitmell, and this will, I think, give the *coup de grâce* to the theory of a subjective effect due to retinal fatigue. In May, 1900, I happened to observe the setting of Venus in the sea from my eclipse camp on the Algerian coast. Observing with a 3-in. inverting telescope, I saw the planet when very near the horizon suddenly change in colour from dull red to vivid green, and as I lowered the telescope to the point where the sea horizon about bisected the field of view I was amazed to see *two* green images of Venus, one, the normal image, ascending from below, and the other sloping down from above. This was probably reflected from the sea itself. The setting took place at the moment of meeting of these two images. The whole apparition, from the moment when the colour changed from red to green, to the instantaneous disappearance of the two images, cannot have lasted more than four or five seconds. The sea about this time was found to be excessively cold, although the air was hot during the daytime, and this state of things would doubtless favour the production of a relatively dense layer of air on the surface of the sea in calm weather.

JOHN EVERSHED.

Kodaikanal, April 13.

The Larger Ions in the Air.

IN addition to the well-known small ions, which are of a type common to all gases, two classes of larger ions exist in the air under ordinary conditions. One of these consists of the large ions of Langevin which have a mobility of about 1/3000, while the other contains ions with a mobility of about 1/50. As the latter value lies between those of the mobilities of the small and large ions, the members of this latter class may be called the ions of intermediate mobility, or, shortly, the intermediate ions.

The slow movement of these larger ions in an electric field clearly indicates that they are molecular clusters of more or less complexity. Ordinarily the value of the mobility is the only guide to the nature of the ionic structure, but in the case of the large ion, at least, an important deduction is to be made from the outcome of experiments on the formation of clouds in closed vessels.

It is well known, since Aitken's notable work on the subject, that, in ordinary circumstances, the air is crowded with particles, in suspension, on which the water vapour condenses into visible drops if the air becomes slightly supersaturated. These particles,

the number of which varies greatly from time to time, can be removed by filtration of the air through cotton-wool, or, in closed vessels, by settlement with the drops formed by expansions. In general, these nuclei are electrically uncharged, and whatever their nature, are conveniently known as dust particles.

C. T. R. Wilson has shown that in air recently freed from dust, with increasing supersaturations, the first visible condensation takes place on the small ions. It is now known that the circumstances of the condensation remain unchanged during intervals of time extending to days after the removal of the dust. The intermediate and large ions are eminently suitable nuclei for the condensation of water vapour, as their mobilities are largely affected by changes in the hygrometric condition of the air, so the results just mentioned indicate not only that these ions are removed with dust particles, but also that they are not produced in air once made dust-free. There is no doubt that the large ions are present in ordinary saturated air; it appears, then, that filtration removes some rigid nucleus without which at least the large ion cannot be developed.

From the facts which have been stated, the picture of the large ion most readily formed is that of a dust particle round which water molecules are adsorbed to an extent depending on the vapour pressure, the whole being electrified by the attachment of a small ion.

Some idea of the nature of the relation between mobility and vapour pressure which is to be expected in connection with such an ion, may be obtained by comparing, on simple thermodynamic lines, the working of two Carnot's engines, one with unit mass of a mixture of ions and water vapour as the working substance, and the other with unit mass of water and its vapour. The vapours are to be taken as perfect gases, and it is to be assumed that the density of a vapour is small compared with that of the substance in the corresponding denser state. With these assumptions the result is readily obtained that $(p_1/p_2)m = (P_1/P_2)^{1/n}$, when only the change of state is being considered. p and P are the values of the vapour pressures in the two engines at the same temperature, and n is the ratio of the latent heat of vaporisation of water to that of the fluid surrounding the nucleus of the ions. It is convenient here to take m as the mass of the denser part of the substance. The expression, which holds for all cases of adsorption, states that at two temperatures the mass adsorbed will be the same if the ratio of the vapour pressures, in equilibrium with the adsorbed fluid, is the nth root of the ratio of the saturated vapour pressures at those temperatures. It is the formula of reduction for adsorption observations taken at different temperatures, and a clue to the condition of the adsorbed moisture is to be obtained from the value of n found necessary to make the observations fall into line. As the mobility of the ions under consideration, at constant temperature and air pressure, is constant if the mass of the adsorbed fluid remains the same, the formula is directly applicable to mobility determinations if m is taken to refer to the mobility reduced to constant air density.

Trouton, and Masson and Richards, find that the mass of contained moisture in the case of flannel and cotton-wool is a function of the relative humidity. This means that n is unity in the preceding expression. n is also unmistakably unity in connection with the large ion, the determinations of mobility only falling into line if plotted against the relative humidities. The result of such a plot is shown in Fig. 1.

No heat change due to a variation of surface energy is involved in the value of n, so in these cases where $n=1$, as the heat per unit mass necessary to annul a temperature change due to the mere alteration of state is the same as that required to keep the temperature constant when water evaporates, it may be definitely concluded that the molecules in the contained or adsorbed fluid are in the same condition of aggregation as those of water.

In the case of the intermediate ions the determinations of mobility are not accordant enough to allow the value of n to be found in this way with any accuracy, but the fit of the points to a line is on the whole better if the mobilities are plotted against vapour pressures than when set out against the relative humidities. This, according to the preceding expression, corresponds to the physically extreme case when n is equal to some large number, though, so far as could be inferred from the plot, n might not be greater than some small integer. In any case, here the latent heat of vaporisation of water is sometimes greater than that of the adsorbed fluid.

The result of the preceding line of argument, though not conclusive in the present instance, at least suggests the idea that the intermediate ion consists of a rigid core enveloped by a collection of water

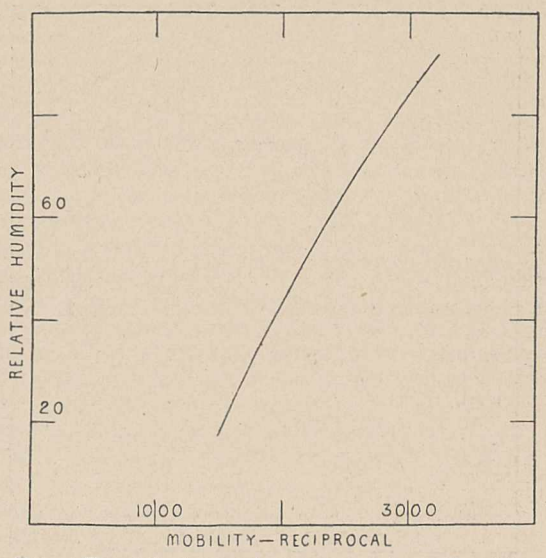

FIG. 1.—The relation between the reciprocal of the mobility of the large ion and the relative humidity.

molecules existing as a dense vapour rather than in the liquid condition.

Trouton, in 1907, made the interesting discovery that there are two modes of condensation of water vapour on rigid surfaces. If special precautions are taken in drying the surfaces, on exposure to water vapour adsorption occurs as a dense atmosphere of water molecules, in a state, perhaps, intermediate between that of a gas and that of a liquid. At any rate, a change to the liquid condition somewhat abruptly takes place in these circumstances when, according to Trouton, the humidity is about 50 per cent. in the case of glass, and about 90 per cent. in that of shellac.

The fluid surrounding the nucleus of the intermediate ion is, no doubt, in a state corresponding to that of the moisture condensed at low pressures on carefully dried surfaces in Trouton's experiments.

Further evidence supports the preceding view of the ion. Fig. 2 shows the relation between the reciprocal of the mobility of the intermediate ion and the vapour pressure as deduced from a plot of the determinations.

At a pressure of about fifteen millimetres the mobility decreases very rapidly with increase in the value of the vapour pressure. Simultaneous observa-

tions of the intermediate and large ions were obtained on many occasions, but with vapour pressures exceeding seventeen millimetres, while the observations of the large ion were equally good, all trace of the intermediate ion disappeared.[1] Disintegration of the ion at a critical vapour pressure is unlikely, and it is much more probable, assuming a rigid nucleus, that the adsorbed fluid is in the condition of a dense vapour, and that at the critical pressure it changes its state to that of a liquid, like the moisture adsorbed by glass and shellac in Trouton's experience.

Such a change means a decrease in the energy of the aggregation, and is to be expected when the molecules of water vapour around the nucleus become sufficiently closely packed. The advent of a liquid surface involves a diminished rate of molecular escape; rapid condensation will therefore occur, with a decreasing unit-surface energy, until further increase in the size of the ion means an increase in the total energy of the mixture of ions and vapour. The final result is no other than the large ion. The assumption of a rigid core for the intermediate ion appears, thus, to be justified.

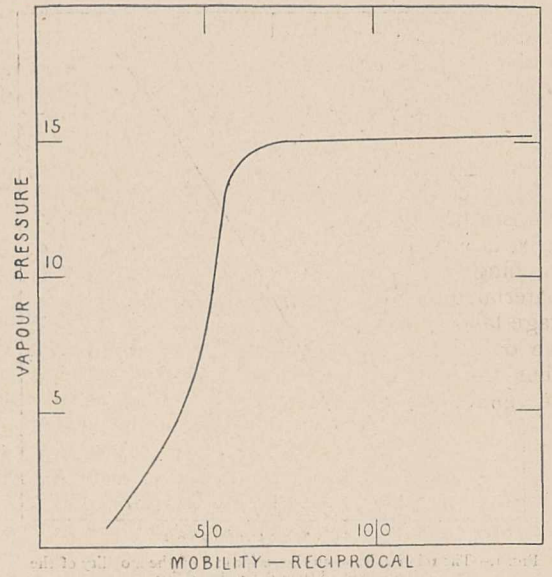

FIG. 2.—The relation between the reciprocal of the mobility of the intermediate ion and the vapour pressure.

To sum up the whole evidence, the large ion consists of a rigid nucleus surrounded by moisture in the liquid condition, the size of the drop at constant temperature depending on the vapour pressure. The intermediate ion is to be considered as a similar nucleus enveloped by a dense atmosphere of water vapour. The mass of the ion increases with the vapour pressure, until at a critical pressure the adsorbed fluid assumes the liquid state, and the aggregation develops, by the rapid condensation which ensues into the large ion of Langevin.

It is not quite clear how the electrical energy of the ions is related to their diameter. The charge is, however, not essential to the equilibrium of molecular structures such as those just mentioned, and it is not unlikely that the conclusions as to the nature of the ions, only rendered possible by the happy chance of their electrification, may apply with, perhaps, little modification to the far more numerous class of unelectrified nuclei which exists in ordinary air.

University of Sydney. J. A. POLLOCK.

[1] Details of these observations will be found in two papers published in the *Philosophical Magazine* for April and May, 1915.

Similitude in Periodic Motion.

IT may interest those of your readers whose attention has been direction to periodic motion to know that by reducing extremely large and extremely small frequencies to a musical base, and employing the middle C (256) as a standard the following results are obtained:—

Green light (frequency $5{\cdot}6 \times 10^{14}$) corresponds to the note C in the forty-first octave above the standard.

The colours—orange, green, and violet—roughly correspond to the musical chord ACE.

Human heart-beats (seventy-five a minute) correspond to the note E (320) in the eighth octave below the standard.

The earth's daily rotation corresponds to the note G (384) in the twenty-fifth octave below the standard.

Neptune's sidereal period almost corresponds with E flat (422) in the forty-first octave below the standard.

HERBERT CHATLEY.

Tangshan Engineering College, Tangshan, North China, March 17.

A Simple Direct Method for the Radius Curvature of Spherical Surfaces.

THE following device was developed to obtain the radius of curvature of some lens surfaces that were too small for the available spherometers. It has proved so satisfactory that, not finding it in any of our

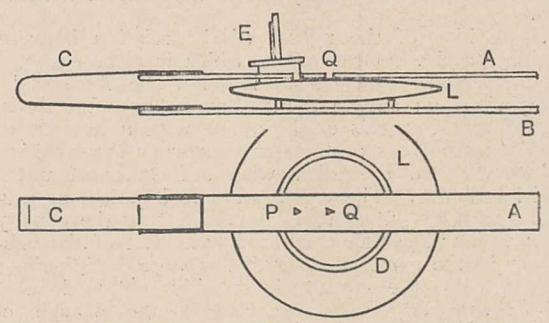

FIG. 1.

laboratory manuals, it has been thought to be of possible interest to others.

Two brass strips, A and B (Fig. 1), are connected by a flat spring, C. To B is soldered a brass ring, D, to serve as a bed for the lens, L, the surface of which is to be examined. A is pierced with two triangular holes, P and Q, as indicated in the sketch, the forward one having its vertex over the centre of the ring. A three-legged optical lever, E, is set with its legs on the glass surface, the front leg being as far forward as possible in one of the triangular holes, P (as shown). The other legs straddle the strip A, one being in contact with A. The lever E is not shown in the lower sketch.

If the mirror be lifted from its position in P to a similar one in which the front leg is at the vertex of Q, it will have been given a linear displacement (s) and an angular displacement (θ). The former of these quantities is the same as the distance between the vertices of P and Q. It is a constant of the instrument, and may be determined by means of a travelling microscope. The angular displacement (θ) depends on the lens surface, and may be obtained by telescope and scale in the usual way. The radius of curvature is then written by $\rho = s/\theta$.

The vertex of Q is placed over the centre of the ring, as this is the simplest way to ensure that the displacement lies along a great circle of the surface.

WILL C. BAKER.

Physical Laboratory, Queen's University, Kingston, Ont., April 19.

HOUSE-FLIES AS CARRIERS OF DISEASE.

THE discovery of the rôle of insects in the transmission of human and animal diseases is one of the most striking achievements of medical science during the last twenty-five years. Filariasis, Texas fever, nagana, malaria, sleeping sickness, yellow fever, dengue, sandfly fever, relapsing fever, plague, typhus, and many other diseases of the lower animals, have been shown to be transmissible by blood-sucking insects—mosquitoes, ticks, tsetse flies, fleas, or lice, as the case may be. The pioneers in this line of inquiry were Manson, Smith and Kilborne, Bruce and Ross.

In a number of cases the necessity of intervention by an insect has been established by the discovery that a portion of the life cycle of the parasite is passed in mosquito, tick, or tsetse fly respectively. In other cases, the evidence rests upon the correspondence in time and space of the incidence of the disease with the presence of some particular insect which has been experimentally shown capable of transmitting the infection. In yet other cases, such as plague, the microbe can also pass directly from patient to patient, as happens in the pneumonic variety of the disease, but the paramount importance of flea transmission in bubonic plague gains in recognition daily.

The rich harvest of discovery reaped by the investigations into the part played by blood-sucking insects in the spread of the above-mentioned diseases naturally stimulated inquiry into the possibilities of insect carriage as a factor in outbreaks of cholera, typhoid, dysentery, and epidemic diarrhœa. These are not diseases in the transmission of which a blood-sucking insect is likely to play a part, for in none of them is the infecting microbe present in the blood-stream in sufficient quantity, but the dejecta, fæces, and often urine, contain the bacilli in countless numbers. A small proportion of convalescents continue to excrete them for weeks, months, and, in the case of typhoid, for years afterwards, although enjoying perfect health. These people are particularly dangerous to the community as they form an unsuspected reservoir of infection.

To produce an epidemic of typhoid, cholera, or dysentery, the bacilli dejected by persons sick or convalescent from the disease must find access to the alimentary tract of others. There are, however, ways in which this may happen independent of the agency of insects. A water supply may become contaminated with infected material; the dejecta may dry up and be distributed as dust, and fall upon food materials (a method, the importance of which may easily be exaggerated, as these bacilli are readily killed by desiccation), or, owing to bacteriologically inadequate attention to cleanliness, food-stuffs, in which the microbes can multiply, may be infected with bacilli from patients or convalescents. Typhoid and cholera bacilli are small objects, less than one-thousandth of an inch in length, so that fingers may be easily soiled by considerable numbers without this being obvious, and the microbes are not removed by perfunctory washing.

Although these three means of spread do produce and maintain epidemics, one has but to consider the habits of the house-fly to realise that this insect may be an able and willing assistant in the distribution of the bacilli which are the cause of cholera, typhoid, dysentery, and diarrhœa, and that flies, if in sufficient numbers, and under conditions favourable for their operations, may constitute the principal way in which infection is distributed. In order to appreciate how this may happen it is necessary to be in possession of some few points in the life-history and structure of the fly.

These subjects have been submitted to careful inquiry during the last few years, particularly in America and this country, by Newstead, Howard, Griffith, Hewitt, and Graham Smith, and we are now well acquainted with this insect, intimate knowledge of which was, until recently, curiously lacking.

The female fly lays about 120 eggs at each laying, and may produce four broods. The eggs are mostly laid on horse manure or other fermenting refuse; they are about 1·5 mm. in length and 0·3 in their greatest diameter, and hatch in from three days to eight hours, according as the temperature ranges from 50° F. to 80° F. The larva is a little active grub 2 mm. long; and on hatching out burrows into the manure or other material on which the eggs are laid. The larval stage lasts five days to three weeks, and pupation five days to a month, according to temperature. Thus the whole cycle from laying of the egg to emergence of the fly occupies ten days to two months, according as the weather be warm or cold. The young female is ready to lay its first batch of eggs in about ten days, or even sooner in warm weather. Owing to this influence of temperature upon the rate of development of egg, larva, pupa, and imago, the number of flies in August depends on the temperature during June and July.

During winter a few flies survive in warm and secluded places. In the spring these start the next year's supply. Dr. Howard, of the United States Department of Agriculture, estimates that in forty days the descendants of one fly might number twelve million, or 800 lb. weight.

It will therefore be obvious that any attempt to overcome the nuisance from flies must, if success is to be achieved, be directed to their breeding haunts, and as early in the season as possible.

The points in the anatomy of the fly of importance for our present object are the legs and feet and the alimentary apparatus. These will be sufficiently obvious from the diagrams (Figs. 1 and 2). The feet are covered with minute hairs, which are more numerous and finer than in the diagram, and extremely fine hairs are also placed upon the pads. A sticky substance is secreted by the surface of the pads, by means of which the fly grips. Each leg is like a minute paint brush, which is

applied to the surface of whatever it rests upon, excrement or food-stuff, as opportunity offers.

The alimentary canal comprises a gullet, stomach, crop, intestine, and rectum (see Fig. 2). The gullet is prolonged forwards to a minute opening between the flaps of the proboscis, halfway down which it is joined by the salivary duct (S D). At the entrance to the stomach (S) it is bifurcated, and one limb of the bifurcation is extended backwards to the bilobed crop (C). By a valvular apparatus at the entrance to the stomach, the insect can direct the liquid driven by the pump in its trunk into either the stomach or crop. The proboscis is a highly elastic muscular organ with universal movement. At the end are two flaps

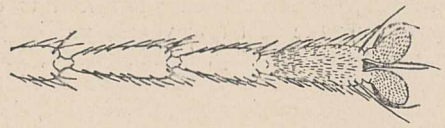

FIG. 1.—Leg of a house-fly.

or labella (only one of which is shown), which it can open out like the leaves of a book, and apply the medial surfaces to the material it feeds upon. From the middle line or hinge, minute chitinous channels pass outwards to the margin. At the base of the trunk a number of muscle fibres are attached to the gullet by the peristaltic contraction of which fluid is pumped up from the mouth and propelled into the stomach or crop. The structural arrangement of the channelled flaps of the trunk acts as a filter, through which solid objects larger than 1/4000th in. seldom pass. When feeding on a liquid, the fly applies the labella to the surface, and sucks the liquid through the

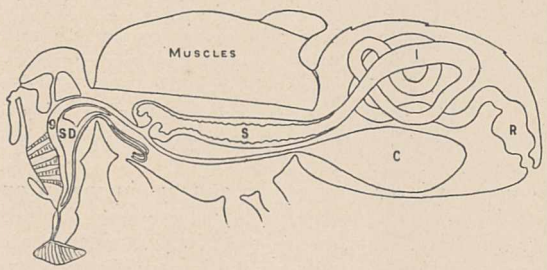

FIG. 2.—Alimentary system of a house-fly.

"strainer" first of all into the crop. When this is full, a further quantity is admitted into the stomach. In the case of solid material, such as sugar, the insect must first dissolve the material. This is done by pouring saliva upon it, or by regurgitating some of the contents of the crop.

A well-fed fly deposits fæces abundantly, and also the contents of its crop upon sugar and other solid objects.

It is clear, therefore, that there are *a priori* reasons for suspecting the fly of carrying bacterial infection. Born in a dunghill, it spends its days flitting between the sugar basin, milk pan, and any fæcal matter available. Its hairy, probably sticky, feet and the habit of regurgitating the contents of the crop and defæcating at frequent intervals, suggest it as an excellent inoculating agent for any bacteria it may pick up in the satisfaction of its catholic tastes. That it does, indeed, operate in this way has been abundantly demonstrated. Flies which have wandered over cultures of organisms and afterwards been allowed to walk upon gelatin plates leave a rich crop of germs in their footprints, which can be demonstrated by subsequent incubation.

Flies fed in the laboratory upon material containing easily identifiable pathogenic microbes have been shown to harbour them in their crops for days, and to deposit them in their fæces and the regurgitations from their crops. Internal carriage is probably more important than soiling of the exterior of the insect, as many pathogenic bacteria soon die from desiccation on the appendages of the insect.

In addition to these laboratory experiments, there are numerous recorded instances in which the pathogenic organisms of cholera, typhoid, phthisis, anthrax, and plague have been recovered from the interior or dejections of flies which have been captured in the immediate neighbourhood of cases of the disease, or, in the last two cases, of carcases of animals dead of the disease.

Although, however, flies may be discovered with the infection of a number of diseases in or upon them, and by their habits may not unlikely serve as agents in transferring infection, it by no means follows that they are the determining factor of epidemicity in the case of cholera, typhoid, dysentery, etc. In the case of fulminating epidemics of typhoid and cholera associated with an infected water supply, this is obviously not so.

It is in temporary encampments of troops or pilgrims, when the disposal of excreta must necessarily be of a primitive character, that the conditions obtain which are most favourable to the breeding of flies and the distribution of infection by them, if cholera or typhoid appear. Even in these circumstances it is difficult to assess the relative importance of fly carriage and other means of spread, but the conclusion that fly transmission is the principal means of spread of typhoid in military encampments and stations has been arrived at by a number of competent observers, amongst them the commission to inquire into the origin and spread of typhoid fever in the United States military camps during the Spanish war of 1898, and by a number of medical officers concerned with the severe outbreaks of enteric which occurred during the Boer war.

The sanitary arrangements of a military camp are not exactly those of the Ritz Hotel, and the prevalence of flies in late summer can scarcely be appreciated by those who have not had camp experience. The conditions are most favourable for transmission of disease by flies, and the circumstantial evidence against them is so strong as to have left no doubt in the minds of the American Commission that these insects play a large part in disseminating infection, for on page 28 of their general statement and conclusions we read:

"Flies undoubtedly served as carriers of infection."

An estimate of the fly population and its relation to admissions for enteric fever was made by Ainsworth in Poona, where enteric has a very definite season. A definite number of fly traps was set, and the daily catch taken as a measure of the fly population. The observations showed that the abundance of flies increased earlier than the admissions for enteric, and, speaking generally, the rise in fly population ante-dated the rise in enteric cases by about one month.

Taking into account the incubation period for the disease, this fact is in agreement with the view of a causal relation between cases and flies in Poona.

In considering the possible influence of flies in the spread of typhoid in a well-sewered city, it must be remembered that the opportunities for them to pick up the infection are vastly fewer than under the conditions of a military encampment, or even in rural surroundings. In large cities with modern sewerage, dejecta and urine from patients may be left available to flies, but the bulk goes promptly into the main drain, and similar observations to those above-mentioned have shown no close relationship, in point of time, between cases of typhoid and prevalence of flies in London, Washington, or Manchester.

As with typhoid, the case against flies as agents in the distribution of the infection of cholera is circumstantial, as other means of spread cannot be excluded. Take, for instance, the case of an accumulation of 300,000 pilgrims in Puri, India, in July, 1912, which was studied by Greig. The sanitary accommodation of the town was inadequate for such an accession to the population. Some of the pilgrims imported the infection of cholera, and an outbreak occurred. Flies in Puri "amounted almost to a plague," and a bacteriological examination of the legs and the contents of the alimentary tracts of flies caught in the neighbourhood of cholera cases demonstrated the presence of cholera vibrios.

Knowing the habits of flies, it is impossible to forgo the conclusion, arrived at by Greig, that some amount of distribution of the infection of cholera was due to their activity. But to what extent they were contributing could only be ascertained by the result of measures directed either to the diminution of their numbers, or to depriving them of access to infectious material.

Greig could not supervise the private latrines of the native inhabitants, but was able to carry out practical measures to prevent flies from visiting dejecta in the case of an outbreak of cholera amongst a limited population in the Puri jail. These were attended with immediate good results.

There are the same general reasons for assuming that fly transmission plays an important part in epidemics of summer diarrhœa of infants as in the case of typhoid and cholera. Anyone familiar with the domestic *ménage* of the average working man on a hot summer day, with the baby sick with diarrhœa, and other small children to care for, must realise that the opportunities afforded for flies to transport the infective agent from the dejecta of one child to the food supply of another are more than adequate.

Epidemic diarrhœa of children does not occur except during that season of the year when flies are abundant and active, and, as will be seen from the accompanying chart, the relation between fly population and diarrhœa cases is so striking as to suggest something more than a mere accidental dependence upon the same phenomena.

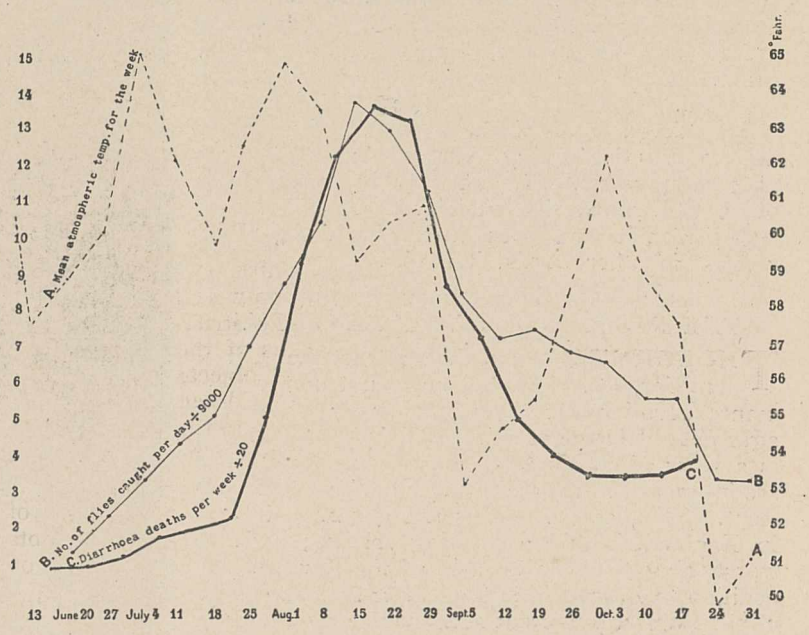

FIG. 3.—Dr. Hamer's observations on relation in point of time between prevalence of flies and diarrhœa mortality in London, 1908. (141 fly-collecting centres.) The deaths from diarrhœa have been antedated 10 days

The chart is constructed from Dr. Hamer's observations on the numbers of flies caught daily in the same number of traps in 141 localities in London during 1908. An important point brought out by these observations is the dependence of both the number of flies and the epidemic upon the cumulative effect of previous warm weather —as, for instance, is indicated by the earth temperature four feet below the surface, a fact to which attention was directed by Ballard in 1889. Similar observations in Manchester, by Dr. Niven, in 1904 to 1906, showed the same relationship.

The reason why the number of flies should be dependent upon this factor is obviously that the generation time (cycle from egg to egg) is

dependent on temperature, and requires three weeks or upwards in our climate. Months of warm weather are therefore required to produce any multitude of flies from the few surviving in the winter. Why the epidemic should exhibit this dependence is not explained, unless on the assumption that the fly population determines the number of cases of diarrhœa.

Without losing sight of the various other ways in which the specific infective agents of cholera, typhoid, epidemic diarrhœa, and dysenteries may be and are transported from the excreta of one individual to the mouths of others, the *prima facie* case against the house-fly is complete.

Further, in the case of infantile diarrhœa, the fly-carriage hypothesis offers a satisfactory interpretation of the extraordinary dependence of the epidemic upon the accumulated effect of temperature, and affords a ready explanation of the spread of the infection of cholera, typhoid, and diarrhœa to neighbouring persons who have no contact with the patient, in those cases in which contamination of a water or food supply may be excluded.

The direct proof of the extent of the danger due to flies is lacking, but the hypothesis has pragmatic value. It not only interprets facts otherwise awkwardly explained, but measures based upon it have been attended with beneficial results; in other words, it works.

THE RESURRECTION OF BABYLON.[1]

THOUGH scarcely a book to attract the general reader, Dr. Koldewey's account of the German excavations on the mounds which have for ages entombed the remains of Babylon the Great, is a work of considerable importance for all who are interested in the archæology of the Old Testament. This, as perhaps is not generally known in England, is still a growing science; and the worst thing that can be said of the German Expedition to Babylonia is that, after so many years of patient and persistent spadework on one of the most promising sites in the world, it has not yet succeeded in unearthing anything of higher historical or religious value than is recorded in the volume before us. Nothing extraordinary has hitherto been found; no great literary monument, no document of supreme religious moment, nothing that lends decisive help towards the settlement of any one of the unsolved problems of history or chronology. How much more fortunate in this respect were the pioneering labours of Layard and George Smith and Botta at Nineveh, of Rassam at Sippara, of De Sarzec at Tellô, of De Morgan and Scheil at Susa!

It is well for us that the Assyrian kings were so deeply interested in the literary monuments of Babylon. Had we depended for our knowledge of these on the remains of the Great City itself, we should (until the recent American discoveries at Nippur) have been left without any indication of the existence of the Babylonian legends of Creation and the Deluge; to say nothing of the many relics of the arts and sciences of Babylon which the library of Assurbanipal preserved for us.

The pathos of the position of the German explorers was that the site had been looted so often previously to their systematic investigations that scarcely anything of first-rate importance was left for the latest adventurers. The temples and palaces of Nebuchadrezzar's capital were probably swept bare of most of their portable treasures at a comparatively early period; and the ravages of people in search of building material, and the petty pilferings of Arabs and other stray visitors, had doubtless robbed the ruins of much that would have been priceless in the eyes of modern explorers. Even the beautiful enamelled bricks,

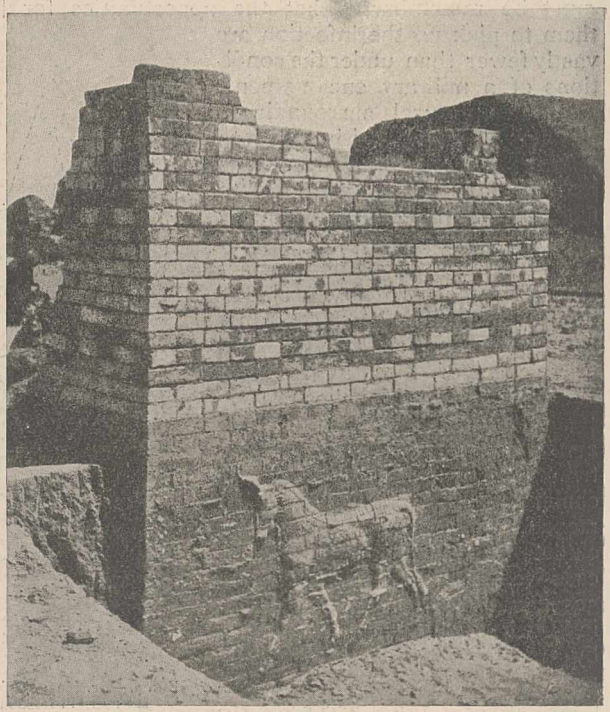

FIG. 1.—Enamelled wall length of the Ishtar Gate. From "The Excavations at Babylon."

with their strange mythological figures, are not altogether a novelty. Older specimens of the same kind of mural decoration were long ago reproduced by Perrot and Chipiez from Sargon's palace at Khorsabad ("History of Art in Chaldea and Assyria," II., plate xv.; see also plates xiii–xiv. Eng. Trans., London, 1884). But it is highly satisfactory to find such splendid examples as those of the Ishtar Gate still existing, *in situ*, and in such an excellent state of preservation (Fig. 1).

Whether anything of supreme value awaits disinterment at lower levels remains to be seen. Slabs of diorite or other hard stone, like the famous stela of Hammurabi, or the similarly written inscription of Nebuchadrezzar, which is (or was) one of the treasures of the library of the

[1] "The Excavations at Babylon." By R. Koldewey. Translated by Agnes S. Johns. Pp. xix+335. (London: Macmillan and Co., Ltd., 1914.) Price 21s. net.

East India House, might well have survived an age-long immersion in Euphratean mud. In any case, disappointing as, in such respects, results have hitherto proved to be, we entirely agree with Dr. Koldewey that it is most desirable that the work of excavating this historic site, begun so many years ago, should be carried to completion. Meanwhile, the special student will not fail to find many good things in this storehouse of facts and comments. It is now certain that ancient accounts greatly exaggerated the extent of ground actually covered by the city, the influence of which dominated the civilised world from the age of Hammurabi, the founder of its imperial greatness, to that of Nebuchadrezzar, who, if he did not find it of brick and leave it of marble, undoubtedly

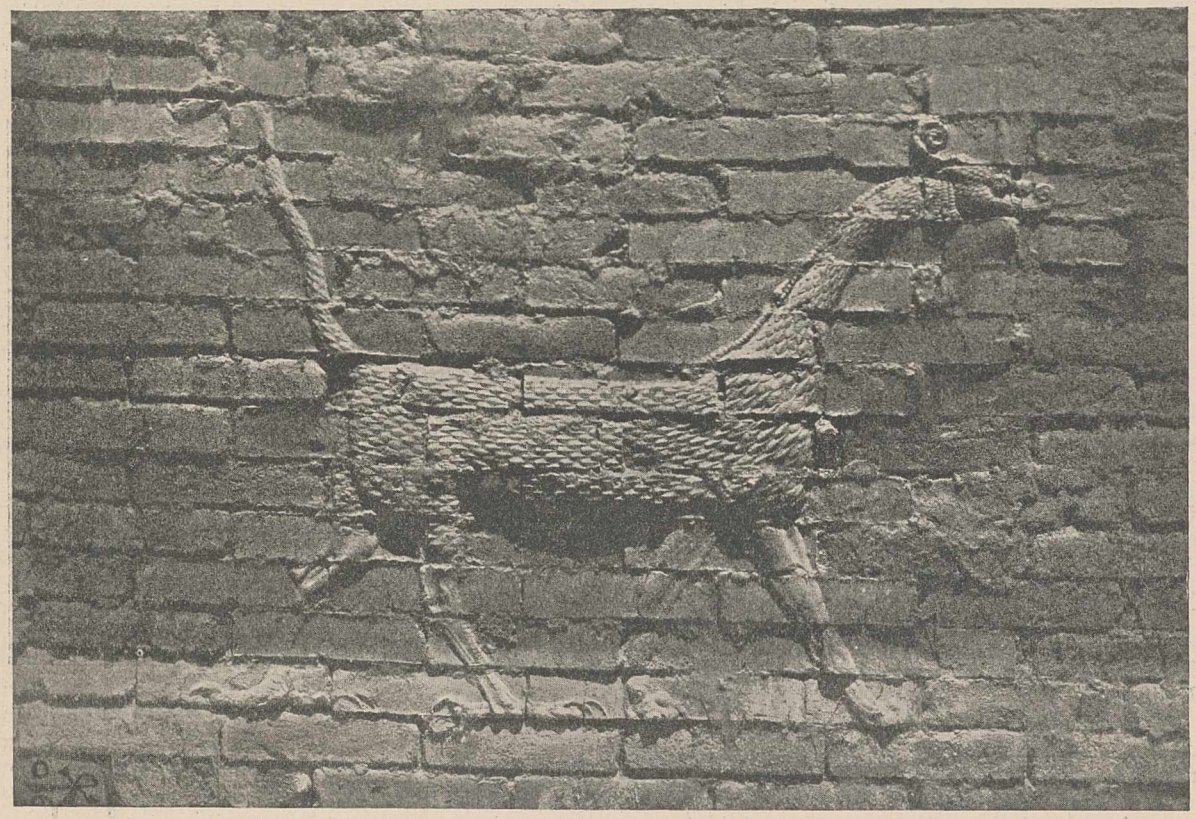

FIG. 2. - A Sirrush. From "The Excavations at Babylon."

restored and enlarged its walls and temples and palaces on so grand a scale that the glories of Babylon the Great became a standing wonder of antiquity. The walls, however, have been found to range from upwards of fifty to more than sixty feet in thickness, and the mounds which concealed them rose to about four times the height of the ordinary *Tels* of buried Oriental cities: circumstances which sufficiently indicate the arduous nature of the task of excavation.

Dr. Koldewey's translations are, for the most part, good and accurate; but in EIH. VI. (not "7") 22–55, the passage in which Nebuchadrezzar or his court historian describes the building of the new eastern wall and the making of the moat, either he or his translator has misunderstood Winckler (KB., iii., 2, p. 23), who explains *IV M amat gagari*, "4000 cubits of ground," as referring to the length of the new wall, not to the distance from Imgur-Bel, and renders *itâti Bâbili nisis lâ dahê*, "an den Seiten von Babylon, in der Ferne, sodass sie nicht herankam," where "sie" also refers to the new wall.

We must also be excused if we demur to the transcription "Sirrush" and the explanation "a walking serpent" (p. 46). The çirrush, or rather, mush-rush, was one of the aqueous monsters created by Tiâmat, to help her in warring down the gods of light. It is something to learn what a MUSH-RUSH was like; and Dr. Koldewey has enabled us to identify it with a form already familiar to us from other Babylonian monuments. It was, in fact, not so much a serpent (though the Sumerian MUSH includes that meaning) as a composite form with serpent head, scales, and tail, and four claw-footed legs—a sort of "laidly worm" or "fearsome dragon," and remarkably like a dinosaurus. The name may denote *fierce* (or *glittering*) *dragon* (Fig. 2).

Dr. Koldewey first visited Babylon in June, 1887, about the time when the present reviewer was working upon the text of the East India House inscription of Nebuchadrezzar (see Proceedings of the Society of Biblical Archæology, December, 1887). What a godsend would the present volume have been in those days, clearing

up as it does by its thorough investigation of local conditions and the actual remains of the ancient buildings so many of the earlier translators' almost hopeless perplexities! One after another, the Procession Street of Merodach, the Sacred Way along which marched the annual solemnity of Babylon's tutelary god; E-MAGH, the temple of NIN-MAGH, "The Exalted Lady," several inscribed cylinders from which may be seen in the British Museum collection; the Gate of Nanâ-Ishtar, with its superb enamelled figures; the palace of Nabopolassar (Nabû-apla-uçur), which Nebuchadrezzar restored with great splendour; the location of E-SAG-ILA, the temple of Merodach, and chief sanctuary of Babylon; the world-famed walls, and various connected structures, were determined and in part exposed to view.

All this, though perhaps not exactly the kind of matter to stimulate the enthusiasm of one who reads merely to while away an idle hour, constitutes a highly important contribution towards an exact topography of Babylon, and to the right understanding of the inscriptions of the Neo-Babylonian period; while it enables classical students to bring to the test of ascertained facts the descriptions of Babylon which we find in Herodotus and subsequent Greek and Latin authors, extracts from whose pages are given in Koldewey's convenient appendix. It is to be hoped that current events in the East may prove no bar to the further prosecution of Dr. Koldewey's meritorious and, indeed, necessary enterprise—even if it happen by the fortune of war that the whole or part of the treasures recovered by his continued labours should find their way to London instead of Berlin.

It should be added that the author has been fortunate in his translator, the English of the book being generally accurate and readable—which is not always the case with translations from German originals.

C. J. BALL.

SCIENCE AND INVENTION.[1]

(1) MR. EDELMAN'S book commences with descriptions of a number of scientific experiments, illustrated by small but clear diagrams. Some of these experiments will be familiar to all those who have taken an experimental course in chemistry and physics, but freshness is given by including simple instances of technical applications of scientific principles. Thus, sections are devoted to "thermit," the electrolytic cleaning of tarnished silver by contact with aluminium in a solution of soda and salt, the preparation of colloidal solutions of platinum and gold, etc. The following description of a method of soldering aluminium may prove useful (p. 47):—

> Aluminium, 1 part; zinc, 4 parts. After the aluminium has been melted add the zinc, then a small quantity of fat. The mixture should be well stirred, after which it may be poured into stick moulds.
>
> To apply, scrape the article bright at place to be soldered. Use a little Venetian turpentine as a soldering fluid. A thin shaving of the solder may then be placed around the joint and melted with a blow torch.

It is impossible to mention the very large number of technical and scientific principles which are described and illustrated; it must suffice to say that these range from the production of Pharaoh's serpents, through electric motors and dynamos, to wireless telegraphy and X-rays. The last nine chapters are devoted to an analysis of the principles used in research and invention. The book is well got up, and forms interesting and instructive reading.

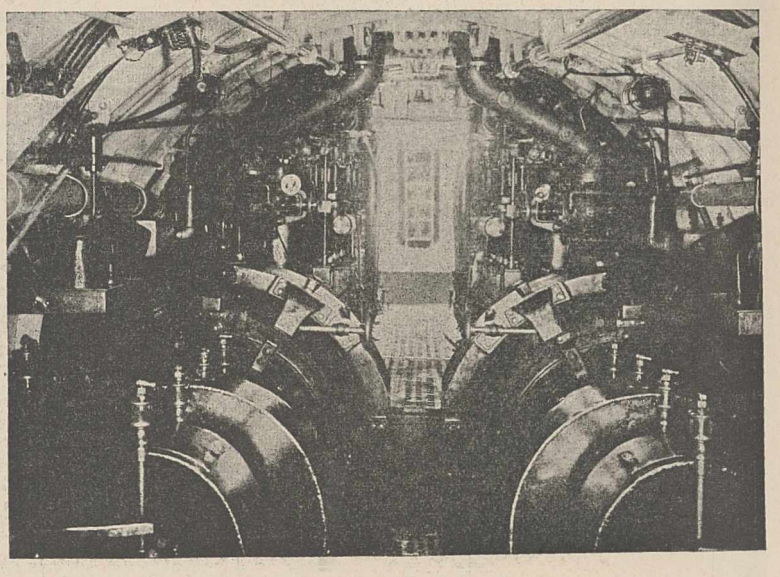

FIG. 1.—Engine room of submarine looking forward. From "Discoveries and Inventions of the Twentieth Century."

(2) Although the twentieth century is still young, Mr. Cressy has found nearly four hundred pages to be none too many in which to describe the progress of inventions made therein. The remarkable improvements which have been made in the details of most industries are clearly brought before the reader. The modern applications of water power, as exhibited in the water turbine and the Pelton wheel; the developments of the steam turbine; the Humphrey pump; improvements in gas, petrol, and oil engines, including the Diesel marine engine, and the "Gnome" engine for aeroplanes; these form a few of the developments described in the first few chapters. Electric lighting is next discussed, and some in-

[1] (1) "Experiments. A Volume for All who are Interested in Progress." By P. E. Edelman. Pp. 256. (Minneapolis, U.S.A.: Philip E. Edelman, 1914.) Price 1.50 dollars.
(2) "Discoveries and Inventions of the Twentieth Century." By E. Cressy. Pp. xvi+398. (London: G. Routledge and Sons, Ltd., 1914.) Price 7*s.* 6*d.* net.

NOTICE.

For the convenience of readers of NATURE wishing to inspect books *published abroad* which have been reviewed in NATURE it has been decided to keep such volumes for the period of six months at the publishing office of the journal. The books will be retained for the purpose of examination free of charge. The display of books began with those reviewed in NATURE of January 7.

St. Martin's Street, London, W.C.

PRINTED IN GREAT BRITAIN BY R. CLAY AND SONS, LTD., BRUNSWICK STREET, STAMFORD STREET, S.E., AND BUNGAY, SUFFOLK.

stances in which electric heating is advisable are mentioned. Later, a brief but lucid account is given of the nature of steel, including the modern alloys of iron and manganese, chromium, nickel, and tungsten. A separate chapter is devoted to the electric furnace. An interesting and instructive chapter is devoted to the artificial production of cold, including liquefaction of gases and the methods used in cold storage. At the present time, when the advisability of increasing the productiveness of agricultural land is receiving attention, the chapters on "soil and crops" will be read with interest.

Railways, tramways, and motor-cars next receive consideration, and the wonderful developments of ship-building are ably dealt with. Great skill has been shown by the author in pointing out the scientific principles which have been utilised in each new technical advance. Thus, in connection with the speed of ships, Prof. Hele Shaw's experiments in fluid motion, and Froude's method of determining the power required to drive a full size ship from experiments on a small-scale model, are described and illustrated. Naturally enough, aerial and submarine navigation receive their due share of attention; the most important types of monoplanes, biplanes, dirigible balloons, and submarine ships are described, and an interesting section is devoted to the gyrostatic compass. Details of the construction and method of firing of the torpedo are also given. The illustrations showing the interior of a submarine (Figs. 1 and 2) will excite considerable interest.

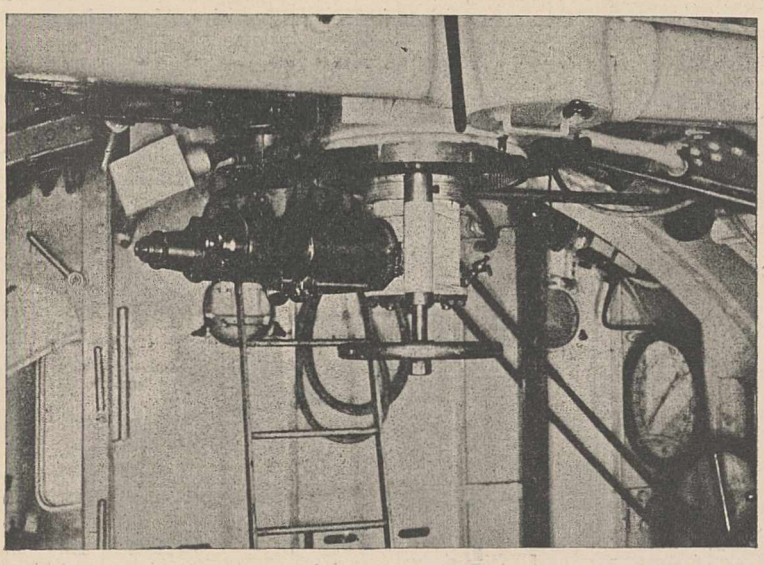

FIG. 2.—Telescope at lower end of periscope tube. From "Discoveries and Inventions of the Twentieth Century."

In reviewing this book, which contains an immense amount of material of the highest interest, it has been found impossible to do more than indicate the aim and scope of the work. Points of scientific interest are mentioned on almost every page, and the reader cannot but admire the painstaking erudition displayed by the author. Books of this character are apt to take the form of undigested summaries of inventions, only partially understood. This is not the case with the book now under review. The author could not hope, and has not attempted, to give exhaustive descriptions of the multifarious technical inventions with which he deals; but these are always described in a stimulating manner, and great accuracy is displayed throughout. The letterpress is illustrated with 281 figures and a coloured frontispiece. EDWIN EDSER.

THE GOVERNMENT AND CHEMICAL RESEARCH.

THE President and Council of the Royal Society and of the Chemical Society have recently had under consideration the state of chemical industry in this country as revealed by the effects of the war, and have prepared memorials to his Majesty's Government directing attention to the necessity for immediate action. On Thursday last a deputation was received by the President of the Board of Trade and the President of the Board of Education at the Board of Trade offices for the discussion of the questions raised in the two memorials. Mr. Runciman and Mr. Pease were accompanied by Dr. Addison, M.P., Sir H. Llewellyn Smith, Sir L. A. Selby-Bigge, Mr. Ogilvie, Dr. Heath, and Mr. Percy Ashley.

The deputation was introduced by Sir William Crookes, who explained the functions of the several societies represented, and it consisted of Prof. A. W. Crossley, Dr. H. J. H. Fenton, Dr. M. O. Forster, Prof. W. H. Perkin, Prof. W. J. Pope, Prof. A. Schuster, Prof. A. Smithells, Prof. J. F. Thorpe, and Mr. R. W. Harrison, representing the Royal Society; Dr. A. Scott, Prof. F. G. Donnan, Prof. P. F. Frankland, Prof. J. C. Philip, Sir W. A. Tilden, and Dr. S. Smiles, representing the Chemical Society; Mr. A. C. Chapman, President of the Society of Public Analysts, Dr. G. G. Henderson, President of the Society of Chemical Industry, and Prof. H. Jackson and Mr. E. W. Voelcker, representing the Institute of Chemistry. Sir H. E. Roscoe and Prof. R. Meldola were prevented from attending by ill-health.

Prof. W. H. Perkin, Sir W. A. Tilden, Prof. P. F. Frankland, Prof. W. J. Pope, and Dr. M. O. Forster spoke on behalf of the deputation. It was urged that the main causes of the comparatively backward state of many branches of chemical industry in this country are the general failure to realise that modern technical industry,

to be successful, must be based on scientific research, and the want of intimate association between the manufacturers and the workers in science. The advisory committee which has been already appointed by the Board of Trade for the consideration of many emergency questions which have arisen, should be replaced by a permanent Standing Committee of the nature of an intelligence department serving the large and growing chemical industries of the country in the same way that the Commercial Intelligence Department serves merchants and traders. It was urged that the chemists of the country generally consider it imperative on national grounds that the development of the new organisation should be pushed forward with as little delay as possible; the expansion of the chemical industries of the country requires intimate co-operation between men of science and manufacturers, and, in view of the leeway which has to be made up, a considerable increase in the number of research workers is necessary in order to hasten progress and to insure the permanent retention of new manufactures after the war. The speakers insisted upon the need for a more intelligent appreciation of the significance of original scientific work by the Government, the urgency for increased facilities of communication between manufacturers and scientific chemical experts, and the fact that an intelligence department of the kind contemplated would, under Government auspices, form a clearing house for all the vast variety of scientific and technological chemical material which is at our disposal; such a department would form a link between the university or college, in which the chemical technologist must be trained, and the industries which would be of immense advantage to both teacher and student. The use which might have been made of the expert knowledge of such a body during the recent preliminaries to the foundation of British Dyes, Ltd., was also indicated.

Mr. Runciman, in reply to the deputation, pointed out that the Board of Trade fully appreciated the extent to which national progress is dependent upon the utilisation of the services of men of science, and the importance of provision for the thorough training of a very much larger number of industrial chemists than are at present available. He agreed with the views expressed as to the need of closer co-operation between manufacturers and scientific workers and teachers. The war had shown the weakness of our position in certain important respects, and he was in full sympathy with the general views expressed by the deputation. The actual proposals would receive careful and sympathetic consideration.

Mr. Pease informed the deputation that the particular problems to which it had directed attention had been present to the Board of Education for some time past, and that a scheme had been approved in principle by which substantial additional assistance would be given by the Government to scientific education and industrial research. He hoped that, though the funds immediately available might not be large, they would be sufficient to enable an organisation to be brought into being at an early date which would be capable of expansion afterwards. Mr. Pease further expressed his appreciation of the offer of assistance and advice by members of the societies represented at the deputation.

Sir William Crookes expressed the thanks of the members of the deputation for the sympathetic reception which they had met.

SIR WILLIAM R. GOWERS, F.R.S.

THE death of Sir William Gowers on May 4, at the age of seventy, deprives English medicine of one of its most illustrious ornaments. The state of his health—which suffered an almost complete eclipse by the death of his wife two years ago—had led to his retirement from active practice, so that the news of his death cannot have been quite unexpected. Yet it will be widely regretted, and the value of his work on the scientific side of medicine will perhaps be more completely realised than if his death had been delayed for some years.

William Richard Gowers was born on March 20, 1845. He was educated at Christchurch School, Oxford, and was for a time apprenticed to Dr. Simpson, a medical practitioner in Essex. He began his medical education at University College Hospital, London, and he had a brilliant career there, and at the University of London. He qualified M.R.C.S. 1867, took his M.B. degree in 1869, and his M.D. in 1870, winning the Gold Medal in Medicine. He became a Fellow of the Royal College of Physicians in 1879. He was also elected a Fellow of the Royal Society. He received the honour of knighthood in 1897.

Gowers's great work in medicine was in systematising the important class of nervous diseases, and in bringing into relation clinical facts with pathological changes. His early works were especially remarkable in this respect, and his clinical teaching—which was peculiarly stimulating to qualified medical men and senior students—always had this as its keynote. He would discuss fully the symptoms of what a patient complained, the clinical signs associated with these, and finally lay down definitely and clearly the changes in the nervous system which his experience had taught him were associated with these signs and symptoms.

It is not necessary here to enumerate the various medical works which he published, or to emphasise their importance. Several of them were translated into more than one European language. His chief work was the "Manual of Disease of the Nervous System," published in two volumes, the first in 1886 and the second in 1888.

Like many busy men he had, or made time for, hobbies. He was an artistic and skilful etcher, and had a great interest in, and an intimate knowledge of mosses, and also of ordinary wild flowers. He was also interested in archæology and architecture, and he himself investigated the remains of some of the old Suffolk churches, and described

their character and reconstructed their history. He had early struggles and difficulties which sometimes made him seem a little austere, but as time went on his innate kindness asserted itself more and more, and his death will be deeply mourned, not only by those who benefited from his professional skill and knowledge, but by many who had experienced generous kindness at his hands.

NOTES.

AMONG the numerous portraits exhibited at the Royal Academy this year three may be specially mentioned. That of Sir Archibald Geikie, painted by Mr. R. G. Eves for presentation to the Royal Society, is a successful and welcome addition to the series of portraits of past-presidents of the society. The Hon. John Collier's portrait of Mr. C. V. Boys is not only excellent in itself, but also noteworthy for the skilful treatment of an experiment in thin films. A portrait of Dr. E. A. Wilson by Mr. H. G. Riviere, destined for Cheltenham College, is of melancholy interest as an appropriate memorial to the naturalist of the National Antarctic Expedition. A striking oil painting by Mr. John Cooke, forms a memento of a discussion on the Piltdown skull which was held in the conservator's room at the Royal College of Surgeons in June, 1913. Prof. Arthur Keith sits at a table covered with the remains of the skull, restored models, and specimens for comparison, while Prof. Elliot Smith stands behind on his right pointing to the disputed middle line of the cranium. Mr. Charles Dawson and Dr. Smith Woodward also stand behind on his left, and Sir Ray Lankester sits at the end of the table beneath them. Prof. A. S. Underwood and Mr. W. P. Pycraft are seated, one on either side of Prof. Keith, and the modeller of the restorations, Mr. F. O. Barlow, stands behind Prof. Smith. All the portraits are excellent, and the composition of the group is pleasing.

PROF. E. W. MARCHANT, of the University of Liverpool, has been elected chairman of the Liverpool Engineering Society for the coming year.

WE learn from the *Lancet* that Prof. R. Newstead, of the Liverpool School of Tropical Medicine, is in France, prosecuting entomological investigations from the point of view of military sanitation.

THE Pereira medal of the Pharmaceutical Society has been awarded to Miss Dora F. White, and the silver and bronze medals of the society to Mr. A. J. Somer and Mr. R. W. Bowles respectively.

WE learn from *Science* that the Draper medal was presented to Dr. Joel Stebbins, professor of astronomy at the University of Illinois, at the annual dinner of the National Academy of Sciences, held on April 20.

MR. T. R. GREENOUGH and his mother have given, in memory of the late Alderman T. Greenough, a complete electrical and radiographic installation to the Leigh Infirmary. It is in three divisions, and its value is estimated at about 5000*l*.

THE Swarthmore lecture of the Society of Friends for the present year will be delivered at the Central Hall, Westminster, on Tuesday next, May 18, at 7.30 p.m., by Prof. Silvanus P. Thompson, who will speak on "The Quest for Truth." There will be no charge made for admission.

IN *Egyptian Illustration* for May Mr. W. G. Kemp announces his discovery of a partially fossilised human skull and associated remains in a cavern in the limestone of the Mokattam Hills, near Cairo. The specimens, which are considered to be prehistoric, are now being studied by Dr. Ferguson at the Cairo School of Medicine.

MR. G. MASSEE has retired from his position as head of the cryptogamic department in the herbarium at the Royal Botanic Gardens, Kew. Mr. Massee joined the Kew staff in 1893, in succession to Dr. M. C. Cooke, and he has rendered valuable service to agriculturists and horticulturists throughout the British Empire in all questions concerning plant pathology.

WE regret to learn of the death of Prof. Erich Harnack, director of the pharmacological institute of the University of Halle, and a brother of the well-known Adolf Harnack. The deceased, a native of the Baltic provinces, was a pupil of Schmiedeberg, in conjunction with whom he prepared, from choline, so-called synthetic muscarine, at one time believed to be identical with the poison of *Amanita muscaria*.

WE learn from the *Irish Naturalist* that the following naturalists in Ireland are among those who have been given commissions in the Army in connection with the present call to national service:—Prof. Gregg Wilson, professor of zoology, and Dr. A. R. Dwerryhouse, lecturer in geology, Queen's University, Belfast; Prof. H. A. Cummins, professor of botany and agriculture, University College, Cork; Mr. C. M. Selbie, of the National Museum, Dublin; Mr. G. P. Farran and Mr. A. B. Hillas, of the Fisheries Office; Mr. H. T. Kennedy and Mr. R. L. Valentine, of the Geological Survey.

THE *Pioneer Mail* for April 16 states that in spite of delays due to the European war, Sir Leonard Rogers's scheme for establishing a School of Tropical Medicine in Calcutta is progressing satisfactorily, and the time when the building will be ready for use is well in sight. The aim of the institution is to investigate specially the cause of tropical diseases and render the best possible relief on practical lines with the view of finding more accurate methods of diagnosis and improved treatment. The fund for building a hospital for tropical diseases now amounts to about 14,000*l*. (paid up), including a recent anonymous donation of 2700*l*. through Dr. K. C. Bose. Plans for the hospital are nearly ready, and the building is expected to be commenced very shortly.

THE third Wilbur Wright Memorial Lecture of the Aeronautical Society will be delivered by Prof. G. H. Bryan, on May 20, at the Royal Society of Arts, John Street, Adelphi. Gold medals of the society, awarded respectively to Prof. Bryan and to the late Mr. E. T. Busk, will be officially presented immediately before

the lecture. The late Mr. Busk played a unique part in the extension to full-sized aeroplanes of the theoretical methods of calculating aeroplane stability due to Prof. Bryan, and lost his life by fire in the air while carrying out his experiments. Machines designed by the methods thus evolved form a large proportion of the valuable aerial equipment of the Royal Flying Corps. Tickets, of which the number is limited, may be obtained on application to the secretary, Aeronautical Society, 11 Adam Street, Adelphi, W.C.

MR. C. S. MIDDLEMISS, of the India Geological Survey, who was a native of Hull, and many years ago spent much time in investigating the geology of east Yorkshire, has made a valuable addition to the geological section of the Hull Museum. He has presented his entire collection, the specimens being all carefully labelled and catalogued, and most of them refer to east Yorkshire. Some years ago Mr. Middlemiss had an opportunity of examining the interesting sections in the Kellaways Rock at South Cave, which were made during the construction of the Hull and Barnsley Railway, and were described in the *Geological Magazine* at the time. The South Cave specimens, together with many others from the red and white chalk, etc., are included, and in addition there is a valuable series of rocks, with a catalogue giving full localities, etc. There is no doubt that Mr. Middlemiss's collection will be of great service to local geologists.

THE British Fire Prevention Committee has done much useful war emergency work during the last nine months. The general honorary secretary, Mr. Ellis Marsland, has issued a statement which shows that the committee's special fire survey force of honorary surveyors has surveyed in detail about five hundred establishments taken over for war emergency work. The character and extent of these establishments varied, but often included extensive groups of buildings. The committee's warning service embraces the preparation and issue of public fire warnings disseminated in the form of posters, or as notices reproduced by technical societies, etc. More than 25,000 posters were issued to auxiliary hospitals at home, in France, in the Mediterranean, and in Egypt, as well as translations in French, Flemish, Urdu, and Panjabi. Refugees' homes and hostels in four hundred localities received about 22,000 warnings in English, French, and Flemish. The issue of farmers' warnings in connection with the epidemic of farm fires last autumn totalled more than 30,000. The number of warnings issued for premises occupied by troops exceeded 25,000. The committee's special fire service force, comprising ex-fire brigade officers and firemen, has rendered two hundred firemen with the necessary appliances readily available for mobilisation in sections within forty-eight hours. Fuller particulars of the various activities of the committee may be obtained from the office at 8 Waterloo Place, Pall Mall, London, S.W.

BRITISH zoology has suffered a distressing loss in the death of Mr. Charles H. Martin, of Abergavenny, who was killed in action on May 3, in the western battle front of the Allies, at the age of thirty-three. Mr. Martin was educated at Eton and Magdalen College, Oxford, took honours in zoology at Oxford, and devoted himself with enthusiasm to zoological research. He worked chiefly, and in recent times almost entirely, at Protozoa, and published important investigations on Acinetaria, on Trypanoplasma and allied forms, and on the cæcal parasites of fowls. Latterly he devoted himself to the study of the Protozoa of the soil, working in touch with the Rothamsted Experimental Station, and published valuable contributions to this subject, either alone or in collaboration with Mr. K. R. Lewin, of the Rothamsted Station. He was awarded the Rolleston memorial prize for his researches. For a time he was in charge of Messrs. Gurneys' laboratory at Sutton Broad, Norfolk, and afterwards assistant in the natural history department of the University of Glasgow for three years, but on his father's death he succeeded to his estate, and gave up all appointments. He continued, however, to pursue his zoological investigations with characteristic energy, in spite of the many distractions and occupations incidental to the life of a sportsman and a conscientious country squire, often carrying on researches at night after a strenuous and fatiguing day. A man of splendid physique, he joined the Officers Training Corps early in his career, and obtained a commission in the 3rd Monmouthshire (Territorial) Regiment, of which he was an officer when he met his death. Possessed of great personal charm and of a most kindly, sincere, and generous temperament, his untimely but glorious death will be greatly deplored by all who had the privilege of being acquained with him personally, as well as by those who knew him only as one of the most promising of our younger zoologists.

IN the Journal of the Royal Anthropological Institute for July–December, 1914, the Hon. John Abercromby discusses a large collection of pottery from the Canary Islands and the bearing of it upon the origin of the people inhabiting the archipelago. He arrives at the following conclusions. The archipelago was first colonised in the second, or Berber, stage of the Neolithic period by a people who spoke a Berber dialect. These colonists probably belonged to the short dolicho- and meso-cephalic stock of Hamitic type, or to the tall Cro-Magnon type. Both were of African origin, and may have arrived together or at short intervals. The short-headed people were presumably of European origin, but archæological considerations show that they may have reached the archipelago about the same time as the other two elements in the population, at any rate before the art of navigation had ceased to be known.

IN a reprint from the Proceedings of the United States National Museum for April last, Mr. Oliver Hay describes remains of two extinct horses, a bison, and a musk ox, also extinct, and new to science, from the Pleistocene of North America. The author believes that it will be necessary to recognise at least two distinct species among the progenitors of our domesticated horses. One of the two supposed species is represented to-day by the large, narrow-

faced horses; the other by the pony-like, broad-faced horses, especially the Celtic pony and the fjord horses of Norway.

AN interesting summary of the "Natural History of the Whale-shark" (*Rhineodon typica*), by Prof. E. W. Gudger, is given in the March number of *Zoologica*, the organ of the New York Zoological Society. Little is known of this fish, the largest of the sharks, and estimates of its length vary immensely, but it would seem that its maximum length is about 45 ft. Prof. Gudger's summary is based upon a specimen captured at Miami, Florida, during June, 1912. Unfortunately, however, he is able to write at first hand only of the stuffed skin of this fish, for the rest he has had to rely on photographs, and the account of Capt. Thompson, who harpooned it. He nevertheless brings together some valuable notes on its coloration, habits, and food, compiled from various sources.

IN "Notes on the Evidences of Age Afforded by the Growth Rings of Oyster Shells" (Fisheries, Ireland, Scientific Investigations, 1913, ii. [1914]), Miss A. L. Massy gives particulars of measurements and of the number of surface lamellæ of the shells of more than 600 oysters of known age and of various ages from eighteen months to six years. Summing up her observations as to the relation between age and the number of surface lamellæ, or growth rings, Miss Massy states that an oyster of eighteen months or two summers appears to possess at least two rings, but may have as many as five; one of three summers has at least two rings, but may have six. A four-year-old oyster may have only three rings, or may possess seven or eight. It would have added greatly to the interest of the paper if these surface rings had been compared with the number of rings shown in sections of the shell.

PUBLICATION DE CIRCONSTANCE, No. 69, of the International Council for the Study of the Sea is entitled "A Contribution to the Biology of the Mackerel: Investigations in Swedish Waters," by David Nilsson. The subjects dealt with are the relation of length to weight in the mackerel, age and growth, food, parasites, sex and maturity, eggs and larvæ, and variation. The material examined, which was collected off the west coast of Sweden, was unfortunately not very large; indeed, scarcely sufficient to justify many of the conclusions which the author attempts to draw from it. On the question of age and growth both the scales and the otoliths have been examined. In the mackerel, however, the appearances seen on both of these are very difficult of interpretation, and the figures given in the paper, which are reproductions (perhaps not very good ones) of photographs, are not very convincing. The author considers that mackerel of 120 to 210 mm. long in August, September, and October are derived from eggs spawned in the same year, although he shows that spawning in Swedish waters takes place principally in July. Much further research on a far more extensive scale is required before our knowledge of the life-history of the mackerel can be regarded as adequate and trustworthy.

IN his report on the survey operations for the year 1913–14 (New Zealand Department of Lands and Survey) Mr. E. H. Wilmot, who has recently taken up the duties of Surveyor-General, sets forth the work of the year and shows the steady progress which has been made. Work on the second-order triangulation seems to have been mainly preparatory for future field work, and to include the computation of observations previously made. The magnetographs at the observatory were kept continuously in operation, and the discussion of the field observations of the magnetic survey is well advanced. The observatory also co-operated with the staff of Captain Scott's Antarctic Expedition in pendulum observations, determination of times, transmission of time signals, etc., rendering thereby much valuable assistance to the expedition. An appendix treats briefly of the measurement of the Kaingaroa base, about 11·5 miles in length, for the second-order triangulation. The probable error of the measurements is small, but a complete discussion of the base and its relation to others in the network cannot yet be given.

THE two sections of *Science Abstracts* issued April 26 do not show any marked decrease in the number of scientific papers with which the publication has to deal in the interval between two issues. The Physics Section extends to forty-eight and the Engineering Section to forty pages. We notice in the former abstracts from the autumn and winter numbers of the *Annalen der Physik*, but there is nothing in the Engineering Section to correspond.

THE *Scientific American* for April 17 describes the American form of the metal-spraying "pistol" invented by a Swiss engineer, Mr. Schoop. A thin metal wire is fed at a suitable speed through the tube of a Bunsen burner into the flame, in which it is melted. At this point it is subjected to a rapid blast of air which blows it out of the mouth of the Bunsen in a stream of extremely fine particles. The apparatus is held in the hand very much like a pistol, and the jet may be directed on to any object which it is desired to cover with a thin film of the projected metal. The spray does not appear to damage the object on which it is deposited, and brass has been deposited on silk without its texture being injured.

THE "Appeal to Non-Producing Mathematicians," recently published by Mr. Paaswell in the Bulletin of the American Mathematical Society, and noted in NATURE, January 14, 1915 (vol. xciv., p. 541), has received a reply from Prof. C. N. Haskins in the April number of the Bulletin (vol. xxi., No. 7, p. 343). It will be remembered that Mr. Paaswell directed attention to certain outstanding mathematical problems of engineering, and comment was made in these columns on his omission of reference to aeroplane investigations. It would seem, from Prof. Haskins's comments, that engineers do not find it possible to add to their qualifications the training necessary to cope with such problems, and he suggests the desirability of mathematicians adding the necessary engineering to their mathematics. Unfortunately, however, when mathe-

matical honourmen turn to engineering, they cease to go further in mathematics, as they find it pays better to qualify as engineers. The average mathematician who is not essentially by nature and genius devoted to pure mathematics, finds that it is more to his advantage, and is a far less arduous task, to qualify in physics, chemistry, or engineering, where he may find an outlet for his energies outside the teaching profession. Problems of the class contemplated by Mr. Paaswell depend essentially on a knowledge not so much of engineering as of *applied mathematics*, such as rigid dynamics, hydrodynamics, thermodynamics and conduction of heat, and elasticity, up to the standard of the old part ii. tripos, which is a less attractive sequel to part i. than the engineering tripos. Consequently applied mathematicians proper are few and far between, and a certain class of problems possessing no inherent difficulties is running to waste. Moreover, the few specialists interested in such work can only undertake it in the intervals between professional duties, often occupied with the teaching of engineering students of a very elementary standard.

MESSRS. DICKINSON and Osborne, of the U.S. Bureau of Standards describe in the April issue of the Journal of the Franklin Institute what they term an "aneroid calorimeter." It is an instrument in which equalisation of temperature is secured by means of the thermal conductivity of copper instead of by the convection of a stirred liquid. The calorimeter described, which consists of a thick walled cylindrical vessel of copper in the walls of which are embedded a coil of resistance wire to supply heat electrically, and a platinum resistance coil for use as a thermometer, has been found useful over a wide range of temperatures, and is applicable to a variety of problems. For use at low temperatures the calorimeter is mounted in a jacket surrounded by a bath of gasoline, the temperature of which can be controlled thermostatically to within a few thousandths of a degree at any temperature between $-55°$ and $+40°$ C., or can be changed rapidly in order to keep it the same as that of the calorimeter when heat is being supplied to the latter. A series of check experiments on the specific heat of water shows the order of reproducibility of results which can be obtained to be 1 part in 2000.

A NOTE on radiation pyrometers and their characteristics, by G. K. Buyers and P. D. Foote has been communicated to the April number of the Journal of the Franklin Institute. It heralds the publication of a very complete paper which is to appear from the Bureau of Standards. Some twenty instruments have been examined, including all the ordinary types commonly met with in practice, such as the four due to Féry, and the Foster, Thwing, and Brown pyrometers. It has been established that the Stefan-Boltzmann law, $E=a(T^4-T_0^4)$, is not in general, except by accident, obeyed exactly by any of the pyrometers examined. The similar equation, $E=aT^4.T^{b-4}$ in which b is slightly different from 4 (usually neglecting the T_0 term) is, however, obeyed with sufficient exactness by all total radiation pyrometers. The main factors which influence the value of the exponent b are the geometry and mechanical construction of the instrument; the value of b for twenty thermo-electric pyrometers ranged from about 3·5 to 4·5. The same instrument of the Féry type may have a different exponent according to its use with or without the sectored diagram for increasing the temperature range.

A HIGH-CAPACITY wagon for the South African railways is illustrated in *Engineering* for May 7, together with another wagon of special design and 160,000 lb. capacity, built for transport of whales. These wagons have been constructed by the Leeds Forge Co., Ltd., and are excellent examples of steel rolling-stock. The whale wagon is intended to carry whales over a special 3 ft. 6 in. line a few miles in length from the point where they are brought ashore to the factory, where they are dealt with for the extraction of oil, etc., not far from Durban. The bodies are hauled on to and off the wagon by windlasses. The line is very uneven, and it has been necessary to design the wagon with six-wheeled bogies, so as to keep the axle-loads down to the required limits and ensure the necessary flexibility.

SCREW pumps having blades like those of a steamer's propeller, mounted on a horizontal shaft, are a feature of several large pumping installations in the United States, particularly for drainage and flushing work, where large volumes of water must be handled promptly and rapidly. The latest and largest installation of screw pumps is at New Orleans, and is described in the *Engineer* for May 7. This installation is used in removing the storm-water drainage of the city and its surrounding district, lying between the Mississippi River and Lake Pontchartrain. Eleven screw pumps, 12 ft. in diameter, are now being built to supplement the present pumping equipment, so that the total pumping capacity will be 7,240,000,000 U.S. gallons daily. The rapid removal of storm-water by pumping has a marked influence upon the sanitary condition, since it enables the ground to dry out more rapidly, and thus reduces the unhealthy conditions which result from damp and water-soaked ground in a large city. The total annual rainfall in the district ranges from 62 to 75 in., most of the heavy rainfalls being due to severe but brief storms.

OUR ASTRONOMICAL COLUMN.

METEORS FROM HALLEY'S COMET.—Like the Perseids and Leonids, the meteors connected with Halley's famous comet probably constitute a complete ring. They were first discovered by Lieut.-Col. Tupman while cruising in the Mediterranean in 1870, when the parent comet was near aphelion, and Prof. Alexander Herschel pointed out the significant resemblance between the cometary and meteoric orbits.

This year, in the early mornings of the first week in May, Mrs. Fiammetta Wilson, of Bexley Heath, observed, notwithstanding rather unfavourable weather, several splendid specimens of the Halleyan meteors. Two of these were also recorded by M. Felix de Roy, hon. secretary of the Société Astronomique d' Antwerp, but now resident at Thornton

Heath. One of these, observed on May 6, at 2h. 52m. a.m., was as brilliant as the planet Jupiter, and travelled over an extensive arc from E. to W. (Kent to Wiltshire). Its height according to Mr. Denning's computations, was from sixty-nine to fifty-nine miles, its luminous flight extended over eighty miles at a velocity of about forty miles per second. The radiant point was at 339°−2°. Another fine meteor from the same system was seen by Mrs. Wilson on May 6 at 3h. 23m. a.m., and a smaller one, also observed by M. de Roy, appeared on May 3 at 3h. 2m. a.m., with a height from forty-eight to forty miles. Radiant 335°−2°. These new materials are interesting as affording further corroboration of the identity of the comet and meteors.

COMET 1915*a* (MELLISH).—The following ephemeris is a continuation of that given last week :—

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
May 14 ...	19 9 32	... −22 42·1	
16 ...	14 29	... 25 19·2	... 5·9
18 ...	20 2	... 28 15·4	
20 ...	19 26 22	... −31 32·7	... 5·6

The comet is rapidly moving southwards, and on May 18 will be found a little to the eastward of τ Sagittarii.

THE AUSTRALIAN SOLAR OBSERVATORY.—The March number of the *Scientific Australian* contains a short communication by Mr. P. H. Baracchi on the demand for an Australian Solar Observatory. Mr. Baracchi enumerates the several steps that have been taken to secure such an observatory for Australia, and directs attention to the selected site known as Mount Strombo, the highest summit of a group of hills situated about 6·5 miles west of the centre of the Federal capital and about 2500 ft. above sea-level. For the purpose of testing the "seeing" at the site for the period of a year, Mr. Baracchi and his assistant, Dr. Baldwin, erected in 1911 a 9-in. refracting telescope on the site and built a 19-ft. dome to house it. The result of the observations showed that the local conditions fulfilled the most essential requirements for any class of delicate astronomical work. As yet nothing is very definitely known concerning the future of the observatory, but Mr. Baracchi states that "the Commonwealth authorities seem well disposed to expand the Mount Strombo Observatory, and make it a permanent astronomical institution, including a solar department, but no further steps have, as yet, been taken."

PHOTOGRAPHING THE CORONA.—Writing in the May number of the *Observatory*, Mr. E. B. Knobel directs attention to the subject of whether the best means are employed in photographing the solar corona, and whether our knowledge of the structure of the corona has advanced since the introduction of the photographic dry plate. He is of the opinion that "no results have been secured comparable in value to the photographs of the corona in 1871, which were obtained with wet collodion plates. . . ." and that the time has arrived when the whole question should be investigated and the results of this investigation made use of on the next occasion of a total solar eclipse. In his communication he considers the merits of the three processes—daguerreotype, wet collodion, and dry plates. He refers to the difficulty in the daguerreotype process requiring much practice and experience, and to the principal drawback to its employment for the corona in that the image is only visible by reflected light, and that long exposures are necessary. He points out, however, the perfection of the resulting image. Mr. Knobel advocates strongly a serious attempt to revive the wet collodion process. He says: "There are no difficulties that cannot be surmounted. . . . All the procedure . . . requires practice and experience, and the assistant should have some familiarity with chemical operations. It ought not to be difficult to find a suitable man to train up for eclipse work among process-workers in collodion, as he would already be practised in some of the operations." It is hoped, as Mr. Knobel suggests, that some of the funds provided by the Joint Permanent Eclipse Committee may be utilised to defray the expense of the necessary training in what is almost a lost art, so that the process may be brought into use again for eclipse work.

CIRCULARS OF THE UNION OBSERVATORY, JOHANNESBURG.—A batch of circulars of the Union Observatory, Johannesburg, has just come to hand dealing with a great number of varied observations. Circular No. 19 deals with the proper-motion stars south of declination −19°, and contains three tables of great interest. The first is a list of all stars for which the proper motion is known to exceed a fifth of a second of arc in either right ascension or declination. It includes also many double stars the proper motions of which exceed 0·1″, and a few stars of small proper motion. Table II. consists of those stars for which radial velocities have been published. The third table indicates groups of stars showing community of motion. The six groups given are the sun group, or group nearly stationary with regard to the sun, the 61 Cygnus, Taurus, π Mensa, α Centaurus, and δ Lepus groups. Circular No. 20, among other communications, gives an account of the discovery of variable stars, etc., with Pulfrich's blinkmicroscop, with remarks upon its use in astronomy. Circular No. 21 is devoted to observations made of the transit of Mercury in November last, a 9-in., two 6-in., and a 4-in. telescope being employed. In Circular No. 22 an orbit and observations of comet 1914*e* are given. This comet, as mentioned in this column last week, was discovered independently by several widely distributed observers. Observations of the Galilean satellites of the planet Jupiter made during the period April 8 to December 31, 1914, form the subject of Circular No. 23. These observations are in continuation of the series commenced in 1908. The present series has been compared with the times given in the American ephemeris, which are founded very closely on Damoiseau's tables, but the 1915 comparisons will be made with the Nautical Almanac, as Samson's tables have now been adopted.

SHELLFISH AND SEWAGE.

IT is perhaps only by chance that the conclusion of the work of the Royal Commission on Sewage Disposal should almost coincide with the Shellfish Regulations issued by the Local Government Board. Nothing like the task performed by the Sewage Commission had ever been attempted by a similar body. It met throughout three reigns, during which time its *personnel* underwent notable changes. It interpreted liberally its "terms of reference," and conducted an inquiry which was most comprehensive in scope. It employed a scientific staff who carried out investigations of quite the best kind, and made reports which, for a long time to come, must be regarded as authoritative. It suggested legislation based on great knowledge of the conditions that were to be improved.

After all this it was with a kind of shock of surprise that those interested in the development of the inshore fisheries read the Shellfish Regulations of the Local Government Board, which were published on February 16, and came into force on March 1. For

the last eight years the fisheries authorities have entreated the Board to legislate, and more than once Mr. John Burns assured them that a Bill would be drafted and laid before Parliament; it was believed that this would be necessary. The British Science Guild lent its authority in aid of the agitation. The fishing trade and the public health bodies were equally desirous that something might be done to remove the dangers that were inherent in the unrestricted exploitation of sewage-polluted shellfish beds and layings. It was felt that some comprehensive scheme of regulations, based on the well-thought-out recommendations of the Sewage Commission (and on the reports of the Board's own inspector, Dr. H. T. Bulstrode), was being prepared and awaited a favourable opportunity for consideration by Parliament.

In February last it was seen that the Board possessed power to legislate by Order in Council. Emergency legislation was in the air; and there were probably reasons traceable to the abnormal state of affairs in the country at present which stimulated the Board to action. Anyhow, the Regulations proceeded to establish a means of dealing with sewage-polluted shellfish on quite other lines than those suggested by the Sewage Commission or the fishery authorities. They set up a machinery for closing suspected layings which must invite criticism inasmuch as it can be put in motion without utilising scientific or technical skill. Briefly stated, the Regulations confer power on the local sanitary authorities to prohibit the exploitation of suspected shellfish beds or layings. If the medical officer of health of any local authority *attributes* disease of any kind in his district to the consumption of shellfish he may require the vendor of the food to state what was its place of origin. The disease need not be enteric fever, and it need not be traceable by any process of scientific investigation to the suspected shellfish. If the medical officer *suspects* (for that is what it comes to) that the consumption of shellfish from a certain place is the cause of disease he may ask the local sanitary authority in whose district this place is situated to take action. If the latter authority do not take action they can be compelled to do so by the Board.

Even then no investigation need necessarily be made. The local authority need only invite the fishermen and others interested in the industry to show cause that the shellfish which they place on the public markets are not the means of communicating disease. If they do not produce evidence of this nature the local authority may prohibit fishing on the suspected beds. It is true that the local authorities are invited to make investigations, and that it is suggested that they should base their conclusions on topographical and epidemiological evidence rather than on the results of bacteriological analyses. But many of the shellfish beds which are likely to come under suspicion may be situated in districts where the medical officer of health is a busy man with a private practice, and where the only other official to whom the investigation may be committed is perhaps an imperfectly trained sanitary inspector. No special technical training may be necessary for the consideration of "topographical and epidemiological" evidence, as it is for the conduct of a bacteriological investigation, but it is certain that evidence of the former nature is more easily misinterpreted, and is no less a matter for the expert.

It is not at all certain that this machinery will prove to be effective, for we may strongly suspect that the local authorities of the shellfish-producing districts will resent suspicion being cast on their local industries, and there is nothing to prevent them accepting the unanimous opinion of their local fishermen that the shellfish they market are to be regarded as blameless. This, however, is not our main point. Expert assistance for the investigation of the layings by the local sanitary authorities is easily procurable. There are the inspectors of the Local Government Board itself, as well as those of the Board of Agriculture and Fisheries, and some of the local fishery authorities have officers well qualified to make the necessary investigations. At all events, the sanitary authorities might well have been advised to follow the example of higher judicial bodies and obtain the assistance of assessors to help them in weighing the value of the opinions of the local fishermen. But one need scarcely say more about this; it is surely evident that the question as to whether an area of shellfish-producing foreshore is to be condemned, and a local industry destroyed, is a matter for the application of scientific investigation by men possessing special knowledge.

Then the suggestion conveyed in the covering letter of the Board, accompanying the issue of the Regulations, that stress is to be laid on the value of topographical and epidemiological, rather than bacteriological evidence, may also be criticised. There is no doubt that the Board were influenced by the opinion of the Sewage Commissioners, which rather deprecated the application of bacteriological analyses, *as a matter of routine practice*. In Dr. Bulstrode's last report no use was made of bacteriological methods; also there is, no doubt, much confusion as to "standards of impurity"; and there is no "norm" generally adopted in public health laboratories as to the precise methods of analyses. But much research upon the distribution in nature of intestinal bacteria is in progress, and we may be very sure that the extension of such investigation would soon enable us to utilise bacteriological methods with complete success—at least as an adjunct to whatever other investigations were employed. It is, in fact, unfortunate that the Regulations should have set up a machinery which can be made to work without the employment of scientific assistance, and with respect to a question upon which much research has already been made and much more suggested by the Royal Commission on Sewage Disposal. J. J.

LENGTH STANDARDS AND MEASUREMENTS.

IN his recent presidential address to the Philosophical Society of Washington,[1] Mr. L. A. Fischer, of the Bureau of Standards, gave an interesting historical account of standards of linear measure. He explained the intimate relation which existed between the American and the British official standard of length up to the year 1893. At present the yard is defined in the United States in terms of the metre, but the numerical ratio adopted agrees very closely with that legalised in this country. In fact, the American yard only differs from the British standard by about 0·0001 in. Until 1856 the United States official standard of the yard was for more than forty years a length of 36 in. on an 82-in. brass bar made by Troughton, which had been brought from London by Ferdinand Hassler, the first superintendent of the Coast and Geodetic Survey. Between 1856 and 1893 a bronze yard presented to the United States by the British Government in 1855 was recognised by the Office of Weights and Measures at Washington as the national standard.

The most important part of Mr. Fischer's address is that dealing with the measurement of base lines. During the last thirty years very radical changes have taken place in geodetical operations. End standards,

[1] Journal of the Washington Academy of Sciences, March 4, 1915, vol. v No. 5, pp. 145–159.

"compensated for temperature," were in use when Mr. Fischer was first engaged on the Coast and Geodetic Survey. These gave place to 5-metre contact rods, consisting of a single bar of steel enclosed in a closely fitting wooden case, and covered with padded canvas. For use in the field they were mounted on tripods and placed end to end. In the hands of skilled observers it was possible with this type of bar to attain a degree of accuracy approaching 1 part in 2,000,000. In the elaborate apparatus devised by Dr. R. S. Woodward a line bar was supported when in use on a steel trough and covered with crushed ice, the trough being carried by two trucks travelling on a portable track. Micrometer-microscopes were mounted on supports fixed in the ground at carefully measured intervals approximately equal to the length of the bar. The operation of measuring was effected by bringing the bar under the first two microscopes and then setting the cross-wires of the micrometers on the lines of the bar; then without disturbing the reading of the forward micrometer the bar was displaced longitudinally until the line at its rear end was brought under the forward microscope, while at the same time an observer at the forward end set the micrometer on the line at that end, this process being repeated throughout the length of the base line. A kilometre base measured in this manner was estimated to have an accuracy of 1 part in 3,000,000.

Eimbeck's duplex base bars were next employed on the survey. These consisted of two concentric brass tubes in the inner of which a brass and a steel measuring bar were mounted. The inner tube could be rotated through 180° so as to equalise the temperature of the brass and steel components if one side of the apparatus should be more exposed to direct radiation. This method was in its turn superseded by the introduction of invar tapes. All primary bases of the United States Survey are now measured with invar tapes, tested preliminarily at the Bureau of Standards, and by this means base operations, while maintaining the high degree of precision which the work demands, admit of vastly greater rapidity in the field, with a consequent reduction in the expense involved.

PLIOCENE MAN.

THE discussion originated by the Rev. Osmund Fisher in NATURE of September 4, 1913 (vol. xcii., p. 6), has led to the systematic exploration, by a committee of the Dorset Field Club, of the Dewlish "elephant-trench," and the report on the excavations was read at the anniversary meeting on May 4.

This curious trench in the chalk yields bones of the Pliocene *Elephas meridionalis*, and Mr. Fisher suggested that it was artificial and dug for trapping the elephants. There can no longer be any doubt that the trench was of natural origin. The elaborate plans, elevations, and photographs exhibited by Mr. Charles Prideaux, who superintended the excavations, show clearly that a few feet below the surface the supposed trench divides into a chain of pipes or pot-holes in the chalk connected by a narrow joint. These become very narrow below; but one of them was traced to a depth of 36 ft. One or two of the smaller pipes still show traces of the lining of black clay commonly found in pipes caused by solution in the chalk; the larger ones were filled with chalky sand full of flints, and Tertiary material; many of the flints were beautifully polished. Flakes caused by sudden changes of temperature were also abundant.

Mr. Clement Reid discussed the geological evidence. He thought that it proved the existence of a fissure or joint transverse to the valley of the Devil's Brook. Along this joint a chain of pipes was formed by the action of percolating rain-water. Then the pipes nearest to the valley-bottom acted as "swallow-holes," into which the brook sank, the constant swirl of the water laden with calcareous sand giving the flints the wonderful polish now seen. In short, the Devil's Brook, then flowing at a level 90 ft. higher, was a "winter bourne," which at Dewlish, for part of the year, at any rate, was swallowed up and disappeared into these pot-holes. Such pot-holes are common in the Carboniferous Limestone, though rare in the Chalk. This chain of pot-holes acted as a natural pitfall, into which the elephants fell, or into which their bones were washed; thus far Osmund Fisher was right in calling it an "elephant-trap," though it probably had a natural origin. Mr. Reid saw no sign of human agency in the trench. The date of the deposit must still remain somewhat uncertain, for all the determinable bones belong to *E. meridionalis*, and this species, though mainly Pliocene, may have lived on into early Pleistocene times.

Mr. Reid Moir, in another report, described a number of the flints as showing undoubted human workmanship of eolithic type. Mr. Reginald Smith, however, after an examination of the same specimens, thinks that one or two of them may possibly be worked, the others he rejects.

A report by Mr. Dewey pointed out that a sample of calcareous sand from the trench proved under the microscope to consist mainly of minute rhombs of calcite, such as would be precipitated from a saturated solution. This he thought pointed to an arid climate.

SYSTEMATIC ZOOLOGY OF THE INVERTEBRATA.

AMONG recent systematic papers on the invertebrates, a noteworthy account of the parasitic worms collected on the British Antarctic (*Terra Nova*) Expedition, written by Dr. R. T. Leiper and Dr. E. L. Atkinson, has been published by the British Museum ("*Terra Nova* Zoology." vol. ii., No. 3). From the summary of results we learn that the Ross Expedition of 1841–4 brought back two species of Entozoa; the Scott (*Discovery*) Expedition of 1901–4 four species; the Bruce (*Scotia*) Expedition seventeen species; the French (*Pourquoi Pas?*) Expedition eighteen species; the *Terra Nova* twenty-eight species. These figures show how greatly zoological knowledge has been increased through our latest national Antarctic enterprise. Three of the worms now recorded from the far south had previously been known only from the Arctic regions. Two of these—a Filaria and an Echinorrhynchus—have whales as their hosts in both localities, but the third—a monostomid trematode, *Ogmogaster plicatum*, Creplin—is parasitic in rorquals in the north, and in the Crab-eating and Weddell's Seals in the south; a remarkable divergence in habit.

From home waters there is still much material to be gathered, and C. M. Selbie's important paper on the Decapoda Reptantia of the coasts of Ireland, part 1 (Fisheries, Ireland, Sci. Invest., 1914, i.), adds to the fauna of the Britannic marine area the family Eryonidæ, as represented by four species of Polycheles and four of Eryonicus. These were all taken in deep water off the west coast of Ireland, though the specimens of Eryonicus "lead a free-swimming life at a considerable distance from the bottom." The paper is illustrated by fifteen excellently drawn plates.

A very important paper on those interesting copepod fish-parasites, the Lernæopodidæ, has been published by C. B. Wilson in the *Proc. U.S. Nat. Museum* (vol. xlvii., pp. 565–729). Though dealing especially with species from North American waters, the author gives a revision of the whole family, thus affording a trust-

worthy work of reference for students of the group all over the world. The systematic part of the paper is preceded by a useful introduction to the anatomy and metamorphosis of the parasites, and is illustrated in thirty-two clear plates of diagnostic drawings.

The zoological results of the Abor Expedition (N.E. India) continue to appear in the Records of the Indian Museum. The lately issued part 6 of vol. viii. contains papers on land planarians by Prof. R. H. Whitehouse, terrestrial Isopoda by W. E. Collinge, and Onychophora by Stanley Kemp. The last-named deserve more than passing notice, for the discovery of a Peripatid "at the foot of the eastern Himalaya" is one of the most important faunistic results of recent years; no member of the class had hitherto been found at all as far north as this. The specimens were found under stones in a comparatively small area at an elevation of 1320 ft. From a consideration of the structure of the species, Mr. Kemp considers it allied to the Malayan Eoperipatus, but on account of the total absence of eyes (although the optic ganglia are present), and other distinctive characters, establishes a new genus (Typhloperipatus) for its reception. The unpaired oviduct in the female and the ejaculatory duct (also unpaired) in the male are remarkably long. The eggs are richly yolked, and embryos at various stages were found in the uterus. From the appearance of the embryos and young it is concluded that reproduction takes place only during the wet season.

G. H. C.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Messrs. F. T. Brooks, Emmanuel College, and R. H. Compton, Gonville and Caius College, have been appointed demonstrators of botany, and Mr. T. S. P. Strangeways, St. John's College, has been reappointed demonstrator of physiology. The council recommends to the Senate that the Vice-Chancellor be authorised to countersign and seal certificates of attendance to Belgian students attending the courses of instruction organised by Belgian professors now lecturing in Cambridge.

The Financial Board has presented a report to the Senate in which the financial position and prospects of the University are reviewed. The income of the University chest for 1913 and 1914 was 53,400*l.* and 46,800*l.* respectively, and is estimated at 26,600*l.* for 1915; the corresponding figures representing the receipts of the common University fund are 22,510*l.*, 23,800*l.*, and 15,780*l.* Details are given in the report of the manner in which the board proposes to meet the large deficiency disclosed in the estimates by the temporary suspension of vacant teaching and research posts, of salaries to officials now in the national service, and of contributions to pension and building sinking fund accounts. One of the most substantial items of expenditure under the control of the Financial Board is that of grants to the departmental funds of the scientific departments of the University; these amounted to 5580*l.* in 1914. The accounts of these departments, although controlled by the Board, are not incorporated in those of the University chest or the common University fund, but the board estimates that in 1915 the receipts from fees of the scientific departments of the University will fall some 16,000*l.* to 18,000*l.* below those of 1914. It is evidently not desired that the University contribution towards the upkeep of the science laboratories in the University should be diminished; it is obvious, however, that even in normal times the chest and the common fund could do little to support natural science in Cambridge if the annual revenue of the science laboratories were suddenly diminished by 16,000*l.* to 18,000*l.* The *Cambridge Review* records the number of undergraduates in residence this term as 1097, as against 3181 during the Easter term of 1914.

LONDON.—Lord Rosebery presided at the presentation of graduates on May 5. The annual report of the principal (Sir Henry Miers), his seventh and last report in view of his appointment as Vice-Chancellor of Manchester University, referred to the special work resulting from the war, particularly the training of 1300 officers and educational provision for two hundred refugee students. In his retrospect of his period of office, the principal referred to the report of the Royal Commission, the incorporation of King's College and King's College for Women in the University, the Universities' Congress, the transfer of Bedford College to Regent's Park, the new buildings at the Imperial College and University College, the development of the professoriate, the increase of internal students from 3580 to 4950, and in the number of external candidates, and many benefactions for teaching and research. He looked forward to the time when the University would have a dignified home bearing its own name, and would be adequately endowed; and expressed his complete faith in its power to fulfil all its duties, both local and imperial. Lord Rosebery, in an eloquent address, hoped that as one result of the war, a new spirit of co-operation would enable the University to work out its own salvation. He had never believed that there was anything incompatible between the local and imperial aspects of the work of the University.

The London County Council is prepared to award for the session 1915–16 a limited number of free places at the Imperial College of Science and Technology, South Kensington, S.W. The free places will be awarded on consideration of the past records of the candidates, the recommendations of their teachers, the course of study which they intend to follow, and generally upon their fitness for advanced study in science as applied to industry. Candidates will not be required to undergo a written examination. It is possible that the free places may be extended to two or more years. Particulars may be obtained from the education officer, L.C.C. Education Offices, Victoria Embankment, W.C., and application forms must be returned not later than Saturday, May 22.

SHEFFIELD.—Dr. J. Sholto C. Douglas, lecturer on pathology in the University of Manchester, has been appointed to the Joseph Hunter chair of pathology, in succession to Prof. Dean.

FOUR lectures on the progress of public health in Egypt will be delivered at Gresham College, E.C., on May 18–21, by Prof. F. M. Sandwith, Gresham professor of physic. The lectures are free to the public, and will begin each evening at six o'clock.

WE learn from *Science* that grants for two new buildings to meet the needs of the University of Ohio and for additional tracts of farm land west of the Olentangy have been voted through the finance committee of the lower branch of the State legislature. These extensions would involve an expenditure of 68,000*l.* A domestic science building to cost 30,000*l.* and a shop building for manual training to cost 24,000*l.* are provided. Ninety acres of land would be purchased west of the Olentangy River at a probable cost of 14,000*l.*

A SUMMER School of Mining and Engineering for the South Wales coalfield is to be held in August next at the Technical College, Swansea. The courses of instruction will be seven in number, comprising a surveyor's course (to meet the requirements of the

Coal Mines Act, 1911), one in engineering, one in metallurgy, one for architects and builders, one for teachers (dealing with geology, physics, and chemistry), one on the electrification of collieries, and one on gas detection and analysis and by-product recovery. Further particulars can be obtained from the chief education official, County Hall, Cardiff.

THE number of foreign students in German universities, according to the *Nieuwe Courant*, was 1438 during the last winter semester, as against 4715 in the previous summer. The decline is primarily due to the removal of about 2600 students belonging to hostile countries. The students from Austria-Hungary numbered 547, as against 814 last summer; the corresponding decline was:—For Switzerland from 312 to 146; for Rumania 146 to 111; for Bulgaria 131 to 105; for Holland there was an increase from 37 to 44. During the war foreign students have shown a strong preference for Berlin; the chief decline in their numbers being at Königsberg, Göttingen, Marburg, Munich, Strassburg, Freiburg, and Heidelberg.

SEVERAL gifts in aid of higher education are announced in the issue of *Science* for April 23. Harvard University receives 20,000*l.* by the will of the late Mr. James J. Myers, of Cambridge, Mass., and further bequests amounting to 14,600*l.*, to be devoted to cancer research at the Harvard Medical School, are announced. By the will of Mrs. L. L. Ogden Whaling, of Cincinnati, Miami University receives 54,000*l.* The residue of the estate is to be divided between Miami University and the Cincinnati Museum Association, and it is said that each institution may receive 40,000*l.* The Addison Brown collection of plants offered to Amherst College by Mrs. Brown in memory of her husband has now come into possession of the college. Containing many thousands of specimens collected in the United States, Mexico, Porto Rico, the Hawaiian Islands, and elsewhere, it is the largest accession ever received by the department.

THE Imperial Department of Agriculture for the West Indies has issued revised courses of reading and examinations in practical agriculture. Reading courses have for some years been established under the direction of the department for the purpose of enabling overseers on estates, and others engaged in agriculture, to acquire by reading knowledge they can apply in their everyday work. Examinations are held periodically at various centres in the West Indies for persons who have previous been registered as students in reading courses. Registration in reading courses entitles students to certain publications of the department which are recommended for reading. The certificates awarded by the department at the examinations are intended to be a guarantee of a sound general knowledge of the fundamental principles underlying the practice of agriculture, and also a practical knowledge of at least two crops and their products, such as sugar, cacao, cotton, limes, rice, coco-nuts, and bananas.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 6.—Sir Alfred Kempe, vice-president and treasurer, in the chair.—G. W. **Walker**: Some problems illustrating the forms of nebulæ. The paper is concerned with the form of the surfaces of equal density when a quantity of gaseous material at uniform temperature, and following Boyle's law as regards pressure and density, is at rest under its own gravitation. The differential equation for these surfaces is not linear. In the two-dimensional case Pockels obtained the solution in terms of two arbitrary functions of complex variables. In the paper the solution is put in a form which must give real positive density anywhere. Three cases only are considered which illustrate respectively a ring nebula, a pear-shaped nebula, and a nebula with two equal nuclei. Some consequences of motion of the material are considered.—Hon. R. J. **Strutt**: Observations on the resonance radiation of sodium vapour. (1) The centres emitting resonance radiation of sodium vapour excited by the D lines are not persistent enough to be carried along when the vapour is distilled away from the place of excitation. This result is extraordinary, because it contrasts absolutely with the behaviour of sodium vapour excited electrically. It also contrasts absolutely with the behaviour of mercury vapour, whether excited optically (2536 resonance radiation) or electrically. (2) The resonance radiation of sodium cannot be seen through even a very dilute layer of sodium vapour placed in front of it—a layer quite transparent to white light. This explains why the spot of superficial resonance produced on the wall of a glass bulb can only be seen from in front, when the light passes to the eye without traversing sodium vapour. From the back it cannot be seen, as Dunoyer has observed. (3) The resonance radiation of sodium vapour is changed in intensity when the vapour is placed in a magnetic field. If the exciting flame is weakly salted, the radiation diminishes with increasing field strength. If the exciting flame is strongly salted, the radiation increases to a maximum and then diminishes again. (4) A change in intensity of resonance radiation can also be observed when the exciting flame is placed in the magnetic field. In this case a weak flame gives diminished radiation in the field, while a strong flame gives increased radiation in the field. (5) All the facts summarised under (3) and (4) can be explained qualitatively and quantitatively, so far as the available data will go, by taking into account the known Zeeman resolution of the D lines, and the observed width and structure of these lines as emitted by the flames used. The latter data were obtained by observation with a concave grating of high resolution.—Hertha **Ayrton**: Local differences of pressure near an obstacle in oscillating water. When the water is approaching the mean level there is a diminution of pressure, or partial vacuum, created in the lee of the obstacle. When the water is departing from the mean level the diminution of pressure continues high up on the lee side, but over the lower part there is a pressure in the opposite direction to that of the main stream. The jet in the first part of a swing is due to the local current created by the local difference of pressure; the vortex in the second part of the swing is due to the conjunction of the main stream with the opposing local current set up by the local pressure difference.

Geological Society, April 14.—Dr. A. Smith Woodward, president, in the chair.—S. H. **Warren**: Further observations upon the Late Glacial, or Ponder's End, stage of the Lea Valley. With notes on the Mollusca by A. S. **Kennard** and B. B. **Woodward**. The paper is supplementary to one previously published, and describes additional sections which increase the range of the deposits. They have now been traced for a distance of 6½ miles along the valley and 2¼ miles across it. The section at Hedge Lane, Lower Edmonton, shows several thick, and for the most part undisturbed, Arctic plant-beds, which occur in a deep Drift-filled channel. The relative levels and stratigraphy point to the conclusion that the Hedge Lane deposits belong to a slightly earlier stage of the Low-Terrace River-drift than the deposits of Ponder's End. Broadly speaking, they undoubtedly belong to the same group. It is suggested that it would be a convenience if the

East Anglian word "platymore" were adopted for the underlying eroded floor of country-rock beneath a later accumulation of drift. The importance of this "platymore" surface in the correlation of Drift deposits has been increasingly recognised during recent years. The view that the lower river-terraces are later than the higher river-terraces is supported. Further evidence is also brought forward in support of the view that the Arctic deposits form an integral part of the Low-Terrace Drift. One section appears to suggest that the climate became nearly as temperate as that of the present day before the mammoth and woolly rhinoceros became extinct.

April 28.—Dr. A. Smith Woodward, president, in the chair.—Prof. G. A. J. **Cole**: A composite gneiss near Barna in the County of Galway. The great mass of granite west of Galway town is seen on its northern margin to be intrusive in a metamorphosed series of Dalradian quartzites, limestones, and mica-schists, and has received a foliation which is parallel with the bedding of this series; this foliation is ascribed by the author to the partial absorption of sheets of the bedded series into its mass. Traces of similar intermingling occur in Townparks (Galway town) and west of Barna. At Furbogh Bridge, the granite contains pink crystals of orthoclase, at times 10 cm. long in the direction of the vertical axis, and these have become stranded, as it were, among the foliation-planes of dark green biotite-schist, into which they were carried by an intimate intermingling of the granite with the schist into which it flowed. Quartz and smaller felspar-crystals from the granite abound in the resulting composite gneiss, and the general effect is comparable with that of igneous intermixtures described from County Down and Skye. In the Galway instance, however, there is no sign of general fusion of the invaded rock, which retains its original foliation and controls the structure of the composite mass.—Prof. S. H. **Reynolds**: Further work on the igneous rocks associated with the Carboniferous Limestone of the Bristol district. The paper gives an account of the additional information, concerning the Carboniferous volcanic rocks of north Somerset, which has become available, largely through digging trial-holes, since the publication in the Q.J.G.S. for 1904 (vol. lx.) of a paper by Prof. Lloyd Morgan and the author on the subject. The rocks occur at five localities:—(1) Goblin Combe; (2) Uphill; (3) Limeridge Wood, Tickenham; (4) Spring Cove and Milton Hill, Weston-super-Mare; and (5) Woodspring or Middle Hope. At Goblin Combe, as the result of digging nearly forty trial-holes, it was ascertained that the igneous rocks form two discontinuous, somewhat crescentic masses, each consisting of olivine-basalt overlain by a considerable thickness of calcareous tuff. At Uphill, the evidence obtained was insufficient to determine whether the basalt is a sill or a lava-flow. At Limeridge Wood, Tickenham, where only débris of basalt had previously been recorded, the presence of an oval mass measuring about 60 by 25 yards was proved by digging trial-holes, and the fact that it is completely surrounded by limestone indicates its intrusive character. Several additional exposures are described on Milton Hill, where the lava forms a band about 150 ft. thick. The lava at Middle Hope or Woodspring is shown to form an irregular and discontinuous mass.

Royal Meteorological Society, April 21.—Capt. H. G. Lyons, president, in the chair.—H. Helm **Clayton**: A study of the moving waves of weather in South America. It is the custom in most meteorological services for the forecaster to make a mental estimate of the changes to be anticipated during the succeeding twenty-four or forty-eight hours. In order to improve on this method and to raise forecasting from an art to a science, the author believes it is essential to replace estimates by quantitative measurements of expected changes and to make quantitative forecasts. He gave an interesting example of such a method as applied to one of the Argentine weather maps.—E. H. **Chapman**: Correlation between changes in barometric height at stations in the British Isles. This was an attempt to discover the relationships existing between the changes in the barometric height at one place and another during the same and also different intervals of time. The conclusion arrived at is that the best information for foretelling barometric changes at any station is from a station south-west of it, the statistical measure of the accuracy with which such a change can be foretold being expressed in a correlation coefficient.

MANCHESTER.

Literary and Philosophical Society, April 13.—Mr. F. Nicholson, president, in the chair.—H. **Day**: Some points bearing on the relationship of the fishes and the amphibia. The author deals with three specimens of the so-called parasphenoid bone in *Rhadinichthys monensis* from the Manchester Museum collection. The three specimens together give an excellent idea of both dorsal and ventral surfaces of the bone, so that an accurate description can be given, thus providing material for a determination of the relations and homology of this bone in the Crossopterygian fishes and in the primitive Reptilia and Amphibia. It was shown that in all these groups the bone is really compound, consisting of parasphenoid and basisphenoid combined, and also that the bone is remarkably constant in its form and relations. The remarkable constancy in form was contrasted with the entirely different form of parasphenoid which prevails in fossil and living Dipnoi, and was brought forward as a strong argument in favour of a development of the Tetrapoda from a Crossopterygian Ganoid stock rather than from the Dipnoi. Further, it was pointed out that in all cases this bone takes part in the suspension of the upper jaw, a process of the metapterygoid region of the palato-quadrate uniting with the basipterygoid process of the basisphenoid region of this compound para-basi-sphenoid bone. This "pedicular" connection thus constitutes a form of autostyly common to the Crossopterygii and the primitive Amphibia and Reptilia, but totally different from the autostyly found in Dipnoi, which latter type is never found in the Tetrapoda. Hence the common pedicular autostyly forms another argument in favour of a Crossopterygian derivation of the Tetrapoda as opposed to the Dipnoian derivation.

PARIS.

Academy of Sciences, May 3.—M. Ed. Perrier in the chair.—Gaston **Darboux**: The representation on a plane of the surface of the fourth order with double conic.—G. **Bigourdan**: The comparison of the scintillation and the instrumental undulations of celestial images under various influences. Supplementing an earlier communication the effects of magnetic disturbances, aurora borealis, barometric depressions, neighbourhood of clouds, azimuth, and twilight are discussed, the observations of various observers on these points being quoted.—M. de **Sparre**: The trajectory of projectiles thrown from aeroplanes or balloons.—Pierre **Delbet**: A prothetic apparatus with co-ordinated movements for use after amputation of the thigh. The apparatus described facilitates walking and conceals the deformity.—J. Kampé de **Fériet**: A generalisation of the series of Lagrange and of Laplace.—Pierre **Humbert**: A figure of equilibrium of fluids in rotation.—E. **Vaillant**: The laws of flow in drops through capillary

orifices.—Léon **Bloch**: Optical resonance in the magnetic field.—A. **Leduc**: The determination of the ratio γ by means of the velocity of sound. A discussion of the values of the ratio of the two specific heats of gases and vapours obtained from experimental determinations of the velocity of sound. The author concludes that the values of γ thus obtained are generally inexact.—N. **Arabu**: Studies on the tertiary formations of the basin of the Sea of Marmora.—Henry **Hubert**: The distribution of rain in western Africa.—Henri **Coupin**: The morphogenic action of increased salinity on the marine bacteria. Increasing the salt percentage in the culture media of marine bacilli increases the length of the organisms and in some instances transforms them into true Spirillæ.—Robert **Sorel**: Wounds received in battle and the sun cure. A list of cases cured in the Alexandra Hospital at Monte-Carlo by sun treatment.—Maxime **Ménard**: The radioscopic localisation of foreign bodies by the method of Hirtz.

CALCUTTA.

Asiatic Society of Bengal, April 7.—P. **Brown**: A preliminary note on the prehistoric cave paintings at Raigarh. These were originally discovered on the rock-surface of a shallow cave in the State of Raigarh, Central Provinces, by Mr. C. W. Anderson, of the B.N. Railway, in 1910. This note is the result of a visit to the caves in March, 1915, by the author and Mr. C. W. Anderson. Certain geological evidences were obtained on the occasion, such as agate implements, etc., which have been submitted to the Geological Survey for investigation. The cave containing the paintings is apparently only the ruin of a much larger excavation. At some remote age the entire front must have fallen in, thus hermetically sealing up the cave and preserving the drawings. At a much more recent date the débris which had thus closed up the opening broke away and slipped another stage down the cliff, exposing the remains of the paintings to view. The paintings are mainly hunting scenes, and in some instances bear a remarkable resemblance to the cave paintings at Cojul in Spain, which are said to be 50,000 years old. In the technique there is also a striking similarity to some of the "cross lined" pottery of prehistoric Egypt. The paintings are evidently of very great antiquity, probably older by thousands of years than any other paintings yet discovered in India.—J. **Evershed**: Sun-spots and prominences.—W. **Burns** and S. H. **Prayag**: Grafting the mango-inflorescence. Starting from the observation that the inflorescence of *Mangifera indica*, L., often becomes partly or wholly vegetative, a phenomenon already studied by Burkill and Bose, the authors give an account of experiments on the artificial production of mixed inflorescences by grafting an inflorescence either on a vegetative branch or on another inflorescence, the grafted inflorescence either dying after the ripening of the fruit which it bears or sometimes persisting and producing vegetative axillary branches.—M. O. Parthasarathy **Iyengar**: Observations on the defoliation of some Madras trees. The author takes as his starting point the observation that, in Madras, trees do not remain in a leafless condition during the period of drought, but produce fresh leaves during the latter period, and he concludes that, in the case of Madras trees, the leaf-fall is not due to the failure of water-supply, but possibly due to the necessity of a replacement of the old by fresh, physiologically more efficient leaves, the greater efficiency of the latter being due to their cuticle being less permeable to water, to their stomatal mechanism being more perfect, to their being less charged with excretionary matter and less clogged by dust, and to greater vitality. The fall of the older leaves may also be caused by successful competition of the growing young leaves for supply of materials. The author also directs attention to the fact that prolonged wet weather may cause trees to shed their leaves. He deals in greater detail with a group of trees—called by him the Odina group—which remain in a leafless condition for a considerable length of time, and which flower while in the leafless condition. Defoliation due to salt-laden sea-breezes is referred to, and a number of special cases are considered in greater detail.—P. F. **Fyson**: Note on the flora of the South Indian Highlands. The region considered comprises those parts of the Nilgiri and Palney Hills which rise above the 6500-ft. level. Forty-five per cent. of the 430 indigenous phanerogamic species are endemic in South India and Ceylon, 17 per cent. are shared with the Khasia Hills, 12 per cent. occur also in the temperate Himalayas, and 9 per cent. are Chinese and Japanese.—W. F. **Smeeth**: The geological history of southern India. A general account of the geology of Mysore.—H. C. **Das-Gupta**: Palæontological notes from Hazara. In this paper the author has described a few fossils obtained from the Triassic, Jurassic, Gieumal, and Tertiary beds of Hazara, and these fossils include one new species of Corbula (*C. middlemissii*), and another new species of Nautilus (*N. hazaraenois*).—H. V. **Nanjundayya**: Some aspects of ethnographic work.

BOOKS RECEIVED.

The Earth: its Life and Death. By Prof. A. Berget. Translated by E. W. Barlow. Pp. xi+371. (New York and London: G. P. Putnam's Sons.) 7*s*. 6*d*. net.

The Principles of Fruit-Growing. By L. H. Bailey. Twentieth edition. Pp. xiv+432. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

Fly-Fishing: Some New Arts and Mysteries. By J. C. Mottram. Pp. xii+272. (London: The *Field and Queen* (Horace Cox), Ltd.) 5*s*. net.

Improved Four-Figure Logarithm Table. By G. C. McLaren. Pp. 27. (Cambridge: At the University Press.) 1*s*. 6*d*. net.

The Golden Bough. By Sir. J. G. Frazer. Third edition. Vol. xii. Bibliography and General Index. Pp. vii+536. (London: Macmillan and Co., Ltd.) 20*s*. net.

The Complete Science of Fly Fishing and Spinning. By F. G. Shaw. Pp. xiii+432. (London: The Author, Neville Court, Abbey Road, N.W.) 21*s*.

Tropical Diseases Research Fund. Report of the Advisory Committee for the Year 1914. Pp. iv+248. (London: H.M.S.O.; Wyman and Sons, Ltd.) 2*s*. 3*d*.

New Zealand. Department of Mines. N.Z. Geological Survey. Palæontological Bulletin, No. 2. Revision of the Tertiary Mollusca of New Zealand. By H. Suter. Part i. Pp. v+64+plates. (Wellington, N.Z.: J. Mackay.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1914. Pp. 112. (Hobart: Royal Society.)

Land and Freshwater Mollusca of India. Supplementary to Messrs. Theobald and Hanley's Conchologia Indica. By Lieut.-Col. H. A. Godwin-Austen. Vol. ii. Plates cxxxiii–clviii. Vol. ii. Part xii. December. Pp. 311–442. (London: Taylor and Francis.) 25*s*.

Practical Physical Chemistry. By J. B. Firth. Pp. xii+178. (London: Methuen and Co., Ltd.) 2*s*. 6*d*.

Index to Periodicals. Compiled by various authorities and arranged by A. C. Piper. Vol. i. April–September, 1914. Pp. xxxii+192. (London: Stanley Paul and Co.) 21*s*. net.

Bacon's Contour Atlas. Lancashire and Yorkshire edition. Pp. 41. South Wales edition. Pp. 41. North England edition. Pp. 41. (London: G. W. Bacon and Co., Ltd.) Each 6*d*. net.

Infant Mortality. By Dr. H. T. Ashby. Pp. x+229. (Cambridge: At the University Press.) 10*s*. 6*d*. net.

A First Geography of the British Isles. By W. M. Carey. Pp. vi+169. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Haeckel's Frauds and Forgeries. By Prof. J. Assmuth and E. R. Hull. Pp. 104. (London: B. Herder.) 6*d*. net.

Combinatory Analysis, by Major P. A. MacMahon. Vol. i. Pp. xix+300. (Cambridge: At the University Press.) 15*s*. net.

The Medical Annual, 1915. Pp. cxx+830. (Bristol: J. Wright and Sons, Ltd.; London: Simpkin and Co., Ltd.) 10*s*. net.

DIARY OF SOCIETIES.

THURSDAY, MAY 13.

ROYAL SOCIETY, at 4.—Election of Fellows. At 4.30.—The Development of the Thymus, Epithelial Bodies and Thyroid in the Vulpine Phalanger (*Trichosurus vulpecula*): Elizabeth A. Fraser and Prof. J. P. Hill.—Some Observations on the Development of the Thymus, Epithelial Bodies and Thyroid in Phascolarctos, Phascolomys and Perameles: Elizabeth A. Fraser.—Measurement of the Specific Heat of Steam at Atmospheric Pressure and 104·5° C., with a Preface by Prof. H. L. Callendar.—Thermal Properties of Carbonic Acid at Low Temperatures. II.: C. F. Jenkin and D. R. Pye.

ROYAL INSTITUTION, at 3.—The Movements and Activities of Plants: Prof. V. H. Blackman.

ROYAL SOCIETY OF ARTS, at 4.30.—Indian Trade and the War: Sir C. H. Armstrong.

IRON AND STEEL INSTITUTE, at 10.30.—A Selection of: Diffusion of Carbon in Iron: F. W. Adams.—Supplementary Notes on the Forms in which Sulphides may exist in Steel Ingots. II.: Prof. J. O. Arnold and G. R. Bolsover.—Researches on Iron, Silicon and Carbon Alloys: G. Charpy and A. Cornu.—Corrosion of Iron in Aqueous Solutions of Inorganic Salts: Dr. J. A. Newton Friend and P. C. Barnet.—(1) Relative Corrodibilities of Gray Cast Iron and Steel; (2) Note on the Removal of Rust by means of Chemical Reagents: Dr. J. A. Newton Friend and C. W. Marshall.—Communication on the Heating of an Open-hearth Furnace by means of Tar: Dr. A. Greiner.—Sound Steel Ingots and Rails: Sir R. A. Hadfield and Dr. G. K. Burgess.—The Nature of the A_2 Transformation in Iron: K. Honda.—Brinell Hardness and Tenacity Factors of a series of Heat-treated Special Steels; Dr. A. McWilliam and E. J. Barnes.—Thermo-electric Properties of Special Steels: A. M. Portevin and E. L. Dupuy.—Stress-strain Loops for Steel in the Cyclic State: Dr. J. H. Smith and G. A. Wedgwood.—Detection of Burning in Steel, and Iron, Carbon, and Phosphorus: Dr. J. E. Stead.

FRIDAY, MAY 14.

ROYAL INSTITUTION, at 9.—The Archives of Westminster Abbey: Rev. E. H. Pearce.

IRON AND STEEL INSTITUTE, at 10.30.—A Selection of Papers mentioned above.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Measures of Double Stars: E. Doolittle.—The Mechanics of Spiral Nebulæ: S. Brodetsky.—Note on Schjellerup's Discussion of the Occultations in the Amalgest: J. K. Fotheringham.—The Irregular Movement of the Earth's Axis of Rotation: Contribution towards the Analysis of its Causes: Sir J. Larmor and Col. Hills.—Note on the Solution of Hill's Equation: Sir J. Larmor.—A Method of Solving Spherical Triangles, etc., by the Use of a Simple Table of Squares: H. H. Turner.—The Short Period Variable RR Lyræ: C. Martin and H. C. Plummer.—Preliminary Discussion of Three Year's Observations with the Cookson Floating Zenith Telescope: H. S. Jones.—The Greenwich R—D System: W. G. Thackeray.—*Probable Papers*: A Determination of the Systematic Motions of the Stars from their Radial Velocities: A. S. Eddington and W. E. Hartley.—The Serious Effect of Suspension on the Rate of a Watch: J. J. Shaw.—Dates of Maximum of S Herculis: T. E. R. Phillips.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Distribution of Heat in the Cylinder of a Gas-engine: Prof. A. H. Gibson and W. J. Walker.

MALACOLOGICAL SOCIETY, at 8.—A Dibranchiate Cephalopod (Plesioteuthis) from the Lithographic Stone of Bavaria: G. C. Crick.—Description of a New Species of Zingis from British South West Africa: J. R. le B. Tomlin.—Diagnosis of a New Species of Dyakia: G. K. Gude.

PHYSICAL SOCIETY, at 8.—Precision Resistance Measurements with Simple Apparatus: E. H. Rayner.—Some Novel Laboratory Experiments: F. W. Jordan.—Electrically Maintained Vibrations: S. Butterworth.

SATURDAY, MAY 15.

ROYAL INSTITUTION, at 3.—Advances in the Study of Radio-active Bodies: Prof. F. Soddy.

MONDAY, MAY 17.

ROYAL GEOGRAPHICAL SOCIETY, at 3.—Anniversary Meeting.

VICTORIA INSTITUTE, at 4.30.—Weights and Measures of the Hebrews: Prof. R. S. Kennedy.

ARISTOTELIAN SOCIETY, at 8.—Synthesis and Complexity (Bergson): Miss K. Costelloe (Mrs. Stephen).

ROYAL SOCIETY OF ARTS, at 8.—Foodstuffs: Dr. D. Sommerville.

TUESDAY, MAY 18.

ROYAL INSTITUTION, at 3.—Advances in the Study of Radio-active Bodies: Prof. F. Soddy.

ROYAL STATISTICAL SOCIETY, at 5.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Who were the Cliff-dwellers?: Dr. J. O. Kinnaman.

ILLUMINATING ENGINEERING SOCIETY at 8.15.—*Discussion*: Some Points in connection with the Lighting of Rifle Ranges.

WEDNESDAY, MAY 19.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Wet English Winter of 1914–1915: Dr. H. R. Mill and H. E. Carter.—Report on the Phenological Observations for 1914: J. E. Clark.

ROYAL SOCIETY OF ARTS, at 8.

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