THURSDAY, APRIL 30, 1908.

ANCIENT BRITAIN.

Ancient Britain and the Invasions of Julius Caesar. By Dr. T. Rice Holmes. Pp. xi+764. (Oxford: Clarendon Press, 1907.) Price 21*s.* net.

THIS substantial volume divides itself, roughly speaking, into two halves, of which the first is the text of the author's story of ancient Britain extended so as to include Julius Cæsar's invasions and their more immediate results. The other is devoted to discussions and notes on special subjects, varying greatly in length and importance.

The summing-up at the end of the story is hardly cheerful reading. In some respects the author thinks we have sunk below the level of "those primitive ancestors" who form the subject of his work. He asks in what we have advanced, and answers that we have made giant strides in all that appertains to material civilisation. He proceeds in the following terms:—

"But such improvements hardly enable men to bear up under burdens which are ever increasing. The tourist in a Pullman car is not happier than those who travelled in stage-coach or waggon, and speed deprives him of as much as it bestows; machinery has but substituted fresh evils for those which it destroyed. New superstitions, less gross but not less false, have been engrafted upon the old: but 'pure religion and undefiled,'—how far has it strengthened its hold on the hearts of men?"

The reader will form some idea of the wide scope of his study of the primitive ancestors from the following headings of the chapters on ancient Britain: the Palæolithic age, the Neolithic age, the Bronze age and the voyage of Pytheas, the Early Iron age, Cæsar's first invasion of Britain, Cæsar's second invasion, the results of Cæsar's invasions.

It is to be hoped that Dr. Holmes may prove mistaken when he asserts in his introduction that we already know all, or nearly all, that sepulchres and skulls and coins can teach us of ancient Britain and its inhabitants. He goes on to express views which, if hardly more encouraging, are more likely to be in accord with those of his readers:—

"There is room also for many labourers in excavating stone circles, camps, and earthworks, and determining their age, in exploring habitations, wherever they can be found, and learning what they can teach about those who constructed them. What has been already done in this department has produced the most fruitful results. . . . But such work, which in other civilised countries is an object of national concern, languishes here for want of funds. No British Government can expect support from the intelligence and the public spirit of its constituents in spending money upon archæological research, or has the courage to give them a lead; and where are the wealthy Englishmen who will follow the example of their American cousins in endowing such work?"

At the risk of seeming to digress, we should like to point out that this state of things shows signs of coming to an end, and we may mention as one of our reasons for believing so the appointment not long since of a Royal Commission to report on the antiquities of Scotland. It is devoutly to be hoped that the Government will do more and extend the sphere of its activity so as to include other parts of the kingdom.

We shall now endeavour to give the reader an idea of ancient Britain and its populations as Dr. Holmes conceives of them. He regards the Bronze age as beginning in this country about 1800 years before the Christian era, but many centuries previously the island began to be invaded from various parts of northern Gaul by a Neolithic people, whom he describes as follows (pp. 64–5):—

"The skeletons that have been exhumed from the Neolithic tombs of England, Scotland, and Ireland . . . belong, for the most part, to the same general type. All, or almost all, had long narrow skulls: their faces were commonly oval, their features regular, and their noses aquiline: most of them were of middle height, and their limbs, as a rule, were rather delicate than robust. Men with the same physical characters lived contemporaneously in Gaul and the Spanish peninsula, and are still numerous in the basin of the Mediterranean; and the race to which they belonged is often called the Iberian, though there is no reason to believe that its British representatives belonged to the Iberian rather than to some other branch of the Mediterranean stock. But it is remarkable that while early in the Neolithic age Gaul and Spain, as well as Central Europe, were overrun by invaders of a totally different kind, who were extremely short and sturdy and had broad round heads, there is no evidence that men of this race reached Britain until the very end of the [Neolithic] period, and then only in comparatively small numbers. One would be inclined to infer that tribes of the Mediterranean stock began to migrate into Britain before many of the round-headed race had settled in Gaul. Vain attempts have been made to trace the [Neolithic] migration to its original starting-point by the distribution of the dolmens, or rude stone sepulchres, which are found in many European countries. . . . Everything points to the conclusion that the earliest dolmen-builders of Britain retreated from Gaul before the sturdy round-headed invaders; and it is useless to inquire whether the Mediterranean stock, to which the British, like the earlier French dolmen-builders, belonged, originated in Europe, in Asia, or in Africa. We only know that the oldest traces of the race were discovered in the Riviera."

At this point the author refers to certain philologists, who, like Prof. Morris-Jones, see in the syntax of the Neoceltic languages the influence of a language akin to the Hamitic dialects of Africa, with which it may be supposed to have come in contact after the advent of the Celts to Britain. He asks (p. 405) why it may not have been affected by some such contact before their arrival here. Doubtless that question occurred to Prof. Morris-Jones, but he was probably prevented from answering it in the way which Dr. Holmes would seem to suggest by the fact that there are some sentences of Continental Celtic extant, and that they show few traces, if any, of the non-Aryan syntax referred to. Whether Dr. Holmes noticed that difficulty does not appear, but if he is right in saying that the Neolithic short-heads chased the "Iberians"

—a French historian would probably say "Ligurians" —across the sea to Britain, the difficulty is perhaps removed.

Perhaps the most valuable pages of the book are those in which he demonstrates that the short-headed race was not Celtic. He represents it as wholly different in physical type from the aborigines of Mediterranean stock whom it began to invade in the Neolithic age. Following the lead, if we mistake not, of the ceramic studies of Mr. Abercromby, he treats it as coming "from the Netherlands, from Denmark and its islands, perhaps also from Scandinavia and from Gaul." He gives the following description of it (p. 127):—

"Those immigrants have often been described as a tall, stalwart, round-headed race; but the evidence of sepulchral remains shows that they sprang from various stocks. Those of the type which is commonly regarded as specially characteristic of the Bronze age were taller and much more powerfully built than the aborigines: their skulls were comparatively short and round; they had massive jaws, strongly marked features, enormously prominent brow ridges and retreating foreheads; and their countenances must have been stern, forbidding, and sometimes almost brutal. Similar skulls, which have much in common with the primitive Neanderthal type, have been exhumed from neolithic tombs in Denmark and the Danish island of Falster. But the skeletons which have been found in some of the oldest Scottish cists belonged to men whose average height, although they were sturdy and thick set, was barely five feet three inches, and whose skulls, shorter and rounder than the others, as well as their milder features, proved that they were an offshoot of the so-called Alpine race of Central Europe, of which there were numerous representatives in Gaul. Again there were tall men with skulls of an intermediate type; while others, who combined harsh features and projecting brows with narrow heads, and whose stature was often great, would seem to have been the offspring of intermarriage between the older and the newer inhabitants. Not a single skeleton of the characteristic British round-barrow type is known to have been discovered on French soil: the round-headed inhabitants of Gaul were as conspicuously short as those of Britain were generally tall."

The short-headed invaders began to arrive in comparatively small numbers before the end of the Neolithic age, and bands of them "landed successively through long ages upon our eastern and southern shores" after the Bronze age set in (p. 127); but "there is no evidence that the brachycephalic people who built round barrows ever reached Ireland, at least in appreciable numbers" (p. 432). They seem to have intermarried with the Neolithic aborigines, and possibly in the course of ages they gave up their language in favour of the latter's. In any case, these conclusions would, to all intents and purposes, concern the eastern and southern coasts alone, which are not represented by any known Celtic language, living or dead. So it would be idle to suggest that, in case the language of the short-heads became firmly established here, its influence on subsequent Celtic on our southern and eastern coasts might be very different from that of the language of the Neolithic aborigines more to the west, let us say, on the syntax of Irish and Welsh; for the evidence is wanting in the shape of a Celtic speech embodying the results of the modifying influence in question. Dr. Holmes applies the term aborigines to the populations of Mediterranean stock that were here from the beginning of the Neolithic age, and extends that stock to Ireland (pp. 64, 109, 398). If, as we believe, he is right in his treatment and distribution of these people whom he claims to call the aborigines, it would be natural to suppose them to have left their name to the islands of our archipelago. We allude to the name underlying that of Πρεταvικαὶ Νῆσοι or Pictish Islands. Dr. Holmes will have none of this: he declines to admit that "the Picts represented that race in a special sense" (p. 409). For him "the Picts were a mixed people, comprising descendants of the Neolithic aborigines, of the Round Barrow race, and of the Celtic invaders" (p. 417). This conclusion leaves us not a little puzzled, not only as to how he distinguishes between his last-mentioned Celtic invaders and the main body of Celtic settlers, but as to how he proposes to settle the question of the distribution of his mixed people in the British Isles.

He has exposed with relentless industry all kinds of inconsistencies and mistakes in the theories to which he is opposed, and thereby has rendered great service to the history of ancient Britain. For all that, he is not at his best when teaching their business to the mistaken individuals who set out to study Celtic philology. His usual method is to pit the views of one against those of another, and in the case of views which he cannot accept himself he makes use of all the resources of his critical skill: not invariably so, however, with views which fall in with his own. Thus he virtually denies that ancient Irish had the sound of *p*, and states (p. 411) that M. d'Arbois de Jubainville "reminds his opponents, that *p* is absent from all Ogam inscriptions." This would not be true, as it occurs not less than a score of times in Ogam, and—a fact which excludes doubt as to the sound meant—two of the names which have it happen to be the Latin Pompeius and Turpillius. This statement surprised us not a little, as the learned Frenchman has not been known to devote much attention to Ogam inscriptions. On perusing the review in which he is represented as making his sweeping assertion, we discover that it is conspicuous by its absence. What he did say was that *p* is not found in the Ogam alphabet, which is by no means the same thing; the distance of time between the oldest Ogam alphabet (dating from the beginning of the twelfth century) and the oldest Ogam inscription containing a symbol for *p* may be put down as ranging from five to seven centuries. Dr. Holmes could if he liked have been more accurate, and at the same time leave M. d'Arbois de Jubainville's opponents with plenty of difficulties to engage their attention.

To take another instance, the author uses the following words (p. 421):—

"According to Bede, the place which marked the western termination of the wall of Severus was called in Pictish *Peanfahel*. *Pean* is commonly identified with the Welsh word *penn*, 'a head'; and accordingly it has been inferred that Pictish was 'a Kymric or

semi-Kymric dialect.' Mr. Nicholson, on the other hand, claims to have shown that *Pean* is 'a Goidelic borrowing from the Latin *penna* or *pinna*.'"

The astonishing allusion here to the *western* termination of the wall of Severus might seem at first sight to be a mere misprint for *eastern*; but, on looking at the original, it turns out to be something more, something calculated to create serious uneasiness as to other statements which one has not had time to verify in this volume. Bede's words, as given in Plummer's edition, I. xii. (p. 26), run thus:—

"Incipit autem duorum ferme milium spatio a monasterio Aebbercurnig ad occidentem in loco, qui sermone Pictorum Peanfahel, lingua autem Anglorum Penneltun appellatur; et tendens contra occidentem terminatur juxta urbem Alcluith."

Dr. Holmes rightly acquiesces in the view that *fahel* is an old form of the Irish genitive *fáil* matching a nominative *fál*, "a hedge, a wall"; but this does not, to say the least of it, help the theory that Pictish phonetics were like those of Welsh rather than of Gaelic. As to Bede's *pean* from Latin *pinna*, the author proceeds to show how absurd it is to think that this word "could beget a geographical name." In any circumstances whatsoever, that sort of statement must be hard to prove, so the argument comes dangerously near mere quibbling, and the appeal to Cæsar should have been an appeal to the German Diez, who derives from Latin *pinna* ("Zinne der mauer") the Italian *penna*, "the top, height, or peak of a hill or mountain," and the Spanish *peña*, "a rock, a cliff," instances of which Diez finds in the oldest Spanish records as Latin *penna*. This is not all; a passage in the second volume of Stokes and Strachan's "Thesaurus Palæohibernicus," from a famous Irish MS. written in the early years of the ninth century, has the words *a pinna montis Berbicis usque ad montem Mis*. The latter height was probably Slemish Mountain, in co. Antrim; the Top of the Mountain of the Wether (*vervex*) remains to be identified. But its name in the Book of Armagh shows that *pinna* was current in Irish Latinity, and was capable of forming part of a place-name. From Latin it passed into the Goidelic language, whence Bede's *Pean-fahel*, which is accordingly neither Kymric nor even semi-Kymric. One of the case forms of a feminine *pinna* in modern Irish would be *pinn*, and it was known to O'Reilly, who gives it in his dictionary as a feminine meaning "the summit of a hill or headland."

The foregoing instances will serve to show that the author has not been quite happy in his treatment of the philologists; whether he has been happier with the geologists and astronomers, the ethnologists and archæologists, they could best tell. We regret to be unable for want of space to pass under review the rest of the second part of the work: we have drawn on the excursus treating of the ethnology of ancient Britain. There are others, however, on such attractive subjects as the Cassiterides, the configuration of the coast of Kent in the time of Cæsar, Portus Itius, the place of Cæsar's landing in Britain, and many minor themes. The Clarendon Press has done its part with its wonted success, and the reader has the aid of useful maps, together with good illustrations. As to the work as a whole, one may say that, in spite of certain grave defects and a uniform lack of originality, it is a great monument to the author's industry.

LINEAR ALGEBRA.

Synopsis of Linear Associative Algebra. By J. B. Shaw. Pp. 146. (Washington: Carnegie Institution, 1907.)

THIS work serves three purposes: it gives a bibliography of the subject; a synopsis of the various algebras considered, in a fairly uniform notation, with a classification into families and types; and, in the introduction and § xiii. especially, some general remarks on algebra and its development. Part iii. (pp. 113–134) deals with applications.

Prof. Shaw points out that there are two views of complex algebra:—

"the one regards a number in such an algebra as in reality a duplex, triplex, or multiplex of arithmetical numbers or expressions; . . . the other regards the number in a linear algebra as a single entity, and multiplex only in that an equality between two such numbers implies n equalities between certain coordinates or functions of the numbers."

On this it may be remarked that both views are equally legitimate, and equally useful, but in different ways. The formulæ of a special algebra which are most characteristic and most powerful are those which most naturally associate themselves with the second point of view; an example is afforded by the quaternion formula $V(\alpha V\beta\gamma)=\gamma S\alpha\beta-\beta S\alpha\gamma$. On the other hand, the place of quaternion algebra among its fellows is most clearly shown when we consider a quaternion as a complex (a, b, c, d) of four ordinary numbers, with rules for the addition and multiplication of two such tetrads.

The general impression produced by reading the synopsis is that, after Grassmann and Hamilton, the most remarkable work has been done by Benjamin Pierce. By developing his methods it has been possible to make a classification of linear associative algebras which, so far as it goes, is really exhaustive, and may be said, also, to be a natural classification. Of recent papers, those of Cartan, Frobenius, and Poincaré deserve particular mention; they tend to show that the characters of special algebras can be included in the all-embracing theory of groups.

A few lines (p. 18) are given to a definition of complex numbers by Mr. Bertrand Russell, in terms of logical constants. This is certainly interesting from a philosophical point of view, but it illustrates a tendency on the part of what may be called the Peano school to over-refine their definitions, and become verbose if not tautological. When the theory of real numbers has been logically established, it is sufficient to define a complex algebra in arithmetical terms, without bringing in logical notions *already* used in defining number and arithmetical operations. Why not make use of a symbolism which has been fully

justified, and which immensely abbreviates the statement of new definitions? After all, Mr. Russell's definition, as here given, does not differ essentially from the "umbral" definition (the first of the two previously referred to).

The synopsis is so condensed that it appeals rather to specialists than to general readers. The latter, if interested in the subject, will find it easier to read the more important papers referred to on pp. 5–7, and then gain a comparative view by studying the synopsis.

Prof. Shaw himself has made various contributions to the subject, some of which are contained in the present volume. His summary will doubtless do much to further the study and comprehension of algebra in general. G. B. M.

MEDICAL PHYSICS.

Lehrbuch der medizinischen Physik. By Prof. H. Boruttau. Pp. viii+282. (Leipzig: Johann Ambrosius Barth, 1908.) Price 8 marks.

THIS book is intended for medical students who have completed a course of general physics, and is therefore limited to the study of the physical properties of tissues, the physical changes that take place in the tissues, and physical instruments of importance in physiology and pathology. In view of the slight equipment of most medical students in mathematics in Germany, as in this country, the treatment of the subject is not mathematical, diagrams and simple equations alone being used. Considering the variety of the subjects treated, the book is of very modest size. This result has been attained by keeping theoretical discussions within the narrowest limits, avoiding detail in descriptions of practical methods and apparatus, and by the use of small but excellent diagrams.

According to the author, no similar book to this has been published since that of Adolf Fick, the last edition of which appeared more than twenty years ago. As the scope of the book is therefore unusual, a brief account of its contents may be useful.

Chapter i. is introductory. Chapters ii. and iii. are devoted to the general properties of tissues, which are divided into fluids and solids, and include sections on velocity, energy and its transformations, density and elasticity of the different tissues, contraction of muscle, the levers of the body, locomotion, deformities, blood pressure, pulse, blood flow, surface tension, viscosity, osmotic pressure, and the secretion of urine. Chapter iv. deals with gases in relation to blood and respiration; chapter v. sound, including wave motion, the analysis of sounds, hearing, speech, percussion, and the sounds of respiration and the heart; chapter vi. heat production and temperature, and their relation to food, work and surface of the animal, conductivity of clothing materials, and the laws of thermodynamics; chapter vii. magnetism and electricity: therapeutic use of electricity, the electric properties of muscle and nerve, Röntgen rays, radioactivity, N-rays; chapter viii. optics: photometry, mirrors, lenses, the eye, optical measurements, correction of optical defects, the microscope, immersion lenses, polarimetry, spectroscopy, calorimetry. References to original papers are given.

A feature of the book is the inclusion of many tables of physical quantities, *e.g.* comparative velocities, densities and elasticities of tissues, specific rotations, conductivities of clothing materials.

That the book contains much useful information not usually found in medical students' text-books is undeniable, the section on blood pressure and pulse, and that on the respiratory murmurs, for example, but it is doubtful whether measurements of elasticity of tissues, to which considerable space is devoted, are of much value, owing to the fact that these tissues show great variations according to their nutrition, and that no tissue except bone is a true solid.

In conclusion, it may be doubted whether a book of this kind, dealing mainly with physiological subjects from a physical point of view with a physical classification, is entirely desirable. Physiologists, after a large number of careful researches on the physical phenomena of living tissues, have had to confess that they are no nearer to the discovery of a physical basis of life. The student should, therefore, arrive at a truer view of the present position of the science from books, which deal with the properties of the living organism as a whole, or as an association of different organs, than from a book with an essentially physical treatment such as this.

J. H. R.

OUR BOOK SHELF.

Musée ostéologique; Étude de la Faune Quaternaire, Ostéometrie des Mammifères. By E. Hue. Two vols. Pp. xix+50+186 plates. (Paris: Schleicher Frères, 1907.) Price 24 francs.

To persons interested in cavern-research and cavern-animals, and having no means of access to a museum, these volumes—which are a monument to the industry and perseverance of their author—will no doubt be welcome, and afford adequate means of identifying their "finds" with comparative ease. In this country, however—apart from what may be the case on the Continent—the number of such persons must, we should surmise, be extremely small, and the sale of the work consequently limited. On the other hand, it may possibly be found of use to students of comparative osteology generally, without reference to cavern-research.

The plan adopted by the author is to take the skeletons of all the species of mammals the remains of which are commonly found in caverns, and to arrange their component elements in corresponding series, so that all the skulls, all the humeri, &c., are brought together in associated plates. Each bone (except, of course, those of the skull) and each tooth is figured separately to scale, the scale in the case of each plate being as large as circumstances permit. By means of these figures to scale and measurements, Mr. Hue is of opinion that it will be practicable for anyone to identify such cave-bones—even when imperfect—as may come under his observation.

For this purpose a series of measurements for each bone in the skeleton is recommended, the lines along which these measurements should be taken being indicated in a series of preliminary figures. By the aid of a rule and pair of compasses, such measurements

can be compared with the corresponding dimensions of the specimens figured.

As the entire work is practically an atlas (the text, which is almost solely concerned with the methods of measurement, occupying only fifty pages), there is really no field for criticism. The figures, though perhaps a trifle crude, appear to be very accurate, and even in the case of the smaller teeth the details of structure are fairly well apparent. Practically the only criticism we have to make is that in plates 33 and 35 the last two upper molars of the jackal and Arctic fox are placed in positions different from those they occupy in the jaw, whereas in the case of the dog (plate 32) and fox (plate 34) they are correctly orientated. The work must have involved an enormous amount of labour, and the author is to be congratulated on the manner in which he has carried out what could scarcely have been anything else but a wearisome task.

R. L.

The Children's Book of Stars. By G. E. Mitton. Pp. xii+207; illustrated. (London: Adam and Charles Black, 1907.) Price 6*s*.

As a book for the instructors of small children, this volume should prove useful. As a book for the unaided juvenile, we fear that the "conventional phraseology" which the author deplores in ordinary text-books has not, even here, been sufficiently eliminated. It is, indeed, a very difficult matter to escape wholly from this evil when instructing juveniles, but, on the whole, the writer of the work under notice has succeeded admirably.

The arrangement of the matter is on familiar lines. The earth, the moon, the planets, the sun, comets, meteors, constellations, stars, and nebulæ are successively treated, concisely and clearly. The analogies by which the different points are illustrated are generally well chosen and apt, and are likely to be easily understood by the young people to whom they are expounded. The chapter (xii.) on "What the Stars are made of" appears to us, despite the relative difficulty of the subject of spectrum analysis, to be one of the simplest in the whole book. The volume contains but very few mistakes, though it is curious that the one in this chapter, on p. 169, should have been overlooked. In describing the preceding plate, which shows the coloured spectra of the sun and Sirius, the latter is called Arcturus, although on the plate and later in the same paragraph it is correctly named.

The illustrations are striking, the majority of them being printed in colours, but we fear that the juveniles to whom some of them would appeal would be hopelessly at sea if given the book to read by themselves. Whilst we are doubtful as to the value of the book if used in this way, there can be no doubt that to children of older growth who have young minds to train it will fill a gap, enabling them—with a few hours' start—to answer clearly all those questions which are bound to be asked if the previous instruction has been at all successful.

W. E. R.

Cradle Tales of Hinduism. By Sister Nivedita (Margaret E. Noble). Pp. xv+343. (London: Longmans, Green and Co., 1907.) Price 5*s*. net.

MISS NOBLE, urged by an enthusiasm for modern Hinduism as preached in Bengal which is shared by few of her countrywomen, has edited a pleasant selection of the classical religious tales of India. She divides them into several cycles—snake tales; the story of Siva; Indian wifehood, including the famous tale of Nala and Damayanti; selections from the Mahabharata and Ramayana epics; the adventures of Krishna; tales of the devotees and of great kings. The tales, of course, are derived from a literature familiar to all scholars, and Miss Noble would perhaps have done more useful service to folk-lore by collecting some of the great mass of folk-tales hitherto unrecorded. Her version is pleasant and interesting, but we are doubtful of the prospects of its success in English nurseries.

These stories exhibit too much of the dreamy mysticism of the East, and while largely occupied with phases of religious feeling, possess too little of that spirit of pure adventure which our children in their fairy-tale books are accustomed to expect. To those unfamiliar with classical Hindu religious literature they will form a useful introduction. The reader, however, will be well advised to accept these versions with some reservation, for a double reason. In the first place, there is too much of the Bengali spirit in them; secondly, all the eroticism and coarseness which are unhappily so prominent in this literature, and especially in that characteristic of Bengal, have necessarily been rigidly suppressed, and the student who reads these stories for the first time may be led to form an impression of their delicacy and purity of sentiment which will soon be dissipated on acquaintance with the originals.

The author, again, has hardly kept herself in touch with recent folk-tale study in India. In discussing the Krishna cycle, she appeals to native scholars for the dissection of the varied elements out of which it has obviously been composed. Here she is likely to be disappointed, because critical analysis of a sacred literature of this kind is hardly to be expected from faithful believers. If she had been aware of recent contributions to this subject, such as Mr. J. Kennedy's essay in a recent number of the Journal of the Asiatic Society, and other earlier studies of the same kind, she would probably have modified the rather crude suggestions contained in her preface. Hinduism possesses many merits of its own, but its claim to the attention of the West will not be advanced by carefully ignoring its most prominent characteristics.

Lehrbuch der mikroskopischen Technik. By Dr. Bernhard Rawitz. Pp. viii+438. (Leipzig: W. Engelmann, 1907.) Price 12 marks.

THIS book gives a very complete summary of modern methods employed in microscopical research as applied to animal tissues. The introductory chapter on the microscope is very brief; probably the author considered this part of the subject hardly came within the scope of his compilation. On the other hand, the preparation of material, hardening, embedding, and staining are dealt with at considerable length, and in the second part of the work the application of the methods to particular tissues and organs is detailed in a complete and thorough manner. When treating of apparatus, the author has avoided anything which simulates a list from instrument makers' catalogues, often a difficult matter in a work of this kind.

General staining methods occupy some sixty-five pages, and here we find an extremely useful summary of the uses and application of a large number of stains. Naturally German methods occupy the forefront, and the British reader misses references to such well-known modifications of the Romanowsky stain as the Leishman and the Wright.

In the second part every tissue and organ is separately considered, and the particular methods applicable in each case are detailed at greater or less length. Thus the nervous system has some seventy pages allotted to it. Little or nothing of importance seems to have been omitted from the book, which is adequately indexed, and should form a very useful compendium for the laboratory.

R. T. HEWLETT.

LETTERS TO THE EDITOR.

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

The Presence of Water Vapour in the Atmosphere of Mars.

IN February and March, 1908, Mr. V. M. Slipher succeeded in photographing the lines due to water vapour in the atmosphere of Mars. It was in the "a" band that its presence stood revealed. The detection was rendered possible by the use of plates specially prepared by him for the purpose—23 Seed, bathed in a mixture of pinacyanal, pinaverdol, dicyanin, water, and ammonia—which enabled the spectrum to be photographed somewhat beyond the "A" band. Comparison spectrograms were made of the moon at approximately the same altitude on the same plates, and with exposures to give a like density for both. Repeated plates of the sort were taken, and their consensus shows unmistakably the "a" band stronger in the spectra of the planet than in those of the moon. In the case of the moon, of course, we are looking through our own atmosphere only; in the case of the planet, through its atmosphere as well.

Previous observers—Huggins, Jansen, Vogel, Campbell—had reached discordant conclusions, Huggins and Vogel asserting the presence of water vapour in the atmosphere of the planet, Campbell with much improved spectroscopic means failing to get any indication of it. The reason of this was the instrumental inability at the time these researches were made to examine the spectrum sufficiently far into the red, for it is in the "a" band that the greatest absorption of water vapour occurs, and this was not only beyond the possibility of photography at the time, but beyond even that of visual detection. Thus Vogel went no further redwards than "C," while Campbell tells us in his account of his researches, in which he came to a negative conclusion :—"It is impracticable to observe the groups A, 7450 to 7160 and 7160 to 6870, which are at the extreme red end of the spectrum, and they will not be further considered." In this omission, rendered necessary by the instrumental appliances at the time, lay the failure to perceive the evidence of water vapour in the spectrum of the planet. For, as the following table shows, the intensity of the absorption is much greater in the "a" band than in the lines between it and the D lines, or even in those near the D lines themselves. This is borne out by examination of Mr. Slipher's plates, in which the difference in the "a" band is evident, the broadening of the D lines just perceptible, and nothing predicable of the fainter water-vapour lines.

Relative Strength of the Water-vapour Lines in the Spectrum, according to Rowland.

Substance	Determination 1893. Strength: Lines probably identified	Determination 1893. Strength: Lines certainly identified	Determination 1895.	Wave-length
A 7604 ... Oxygen	120	120	—	7672, 7594
a 7165 ... Water Vapour	124	50	128	7319, 7176
,,	9	—	6	7016
,,	42	13	54	6999, 6948
B 6867 ... Oxygen	170	—	—	6936, 6867
C 6562 (Solar, H) ... Water Vapour	5	5	20	6572, 6480
a ... Oxygen	14	—	—	6296, 6278
Water Vapour	2	2	10	5977
D_1 5896, D_2 5890 (Solar, Na) ,,	26	26	68	5920, 5884

No water vapour lines of less wave-length than 5884.

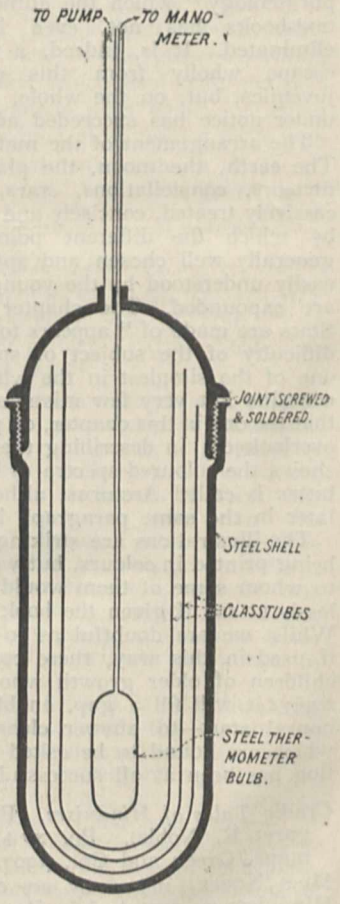
The great dryness of Arizona was no less a factor in the result. So dry was the air at times during the investigation that on more than one plate the "a" band is hardly to be made out in the lunar spectra, while in the Martian it is unmistakable. Great dryness in the climate is in other ways shown by the plates to be essential to the recording of a perceptible difference between the water-vapour lines due to Mars and the earth and those due to the earth alone. For examination of the oxygen bands, A, B, and a, in the two spectra reveals no perceptible difference between them, and yet the presence of water vapour in the spectrum of Mars is strong presumptive evidence that free oxygen exists in its atmosphere as well, since it is the heavier of the two.

PERCIVAL LOWELL.

Lowell Observatory, Flagstaff.

The Condensation of Helium.

I HAVE just read with great interest of Prof. Onnes's experiments with helium, and as one who has carried out investigations at very low temperatures, and to a certain extent in the same direction, I must congratulate him on having overcome difficulties of no ordinary nature. At the time of my departure for India I was engaged in an attempt to measure temperatures below the temperature of solid hydrogen, with the ultimate object of determining thermal constants for helium, but the work was broken off when I left Bristol, and it is not likely that I shall be able to resume it for some time. However, it is possible that brief information as to the method I intended to employ may be of use to others.



The measurement of low temperatures by any means other than by the gas thermometer appeared to me to be mere waste of time, and I decided to employ in these experiments a constant volume helium thermometer. Following the method of Olszewski, I proposed to compress helium to about 100 atmospheres in a vessel cooled in solid hydrogen, and containing the thermometer, and to measure the fall of temperature on expanding the gas. The only obvious difficulty lay in the construction of the apparatus.

The apparatus shown about natural size in the figure was made for me by Messrs. A. Hilger. The outer vessel was of thin steel, and had a capacity of about 40 c.c. Within were three concentric test-tubes, made as light as possible, and separated one from the other and from the steel vessel with fragments of cork. In the centre is a very light bulb of steel, to which was soldered a capillary steel tube such as is used for hypodermic needles. This bulb was intended to serve as a thermometer, the steel tube communicating with the manometric portion of one of the thermometers which I employed in the measurements of the temperatures of liquid and solid hydrogen (Phil. Trans., cc. A, 105, 1902). A steel tube connected the steel vessel

with the pump, &c. A steel gasometer floating on mercury, and a steel pump working with mercury as a lubricant, had also been constructed for me by Messrs. Brin's Oxygen Co. Sir William Ramsay had placed a large quantity of helium at my disposal.

Preliminary experiments with oxygen led me to the conclusion that by this method it would be possible to attain to, and measure temperatures far below, the melting point of hydrogen. I may point out that for very low temperatures the reading of the manometer attached to the thermometer would give a direct measurement of the temperature, as the dead space correction would be very small.

MORRIS W. TRAVERS.

Indian Institute of Science, Bangalore, March 29.

The Radio-activity of Ordinary Metals: the Penetrating Radiation from the Earth.

IN a paper in the *Phil. Mag.*, December, 1907, I described some experiments made by me on the conductivity of air confined in metallic cylinders, 60 cm. long and 24 cm. in diameter, which were made of lead, of zinc, and of aluminium. With the zinc and aluminium carefully cleaned, a conductivity was obtained for the enclosed air, which on reduction gave the value 15 for q, the number of ions generated per c.c. per second in the air. With lead cylinders, which were investigated more extensively than those of other metals, the conductivity exhibited wide variations, and values were obtained which ranged from 160 to 23 ions per c.c. per second.

During the past eight months experiments on the conductivity of air confined in metallic vessels have been continued in the Physical Laboratory at Toronto by Mr. C. S. Wright, and he has now obtained under normal conditions with a particular lead cylinder of the dimensions given above, in a series of observations made in a room in the laboratory, a conductivity corresponding to the production of 15·3 ions per c.c. per second. With zinc and aluminium cylinders, the lowest conductivities obtained in this room by him correspond, respectively, to the values 13·4 and 12·5 ions per c.c. per second for q.

He has also, during this period, conducted a series of experiments on the conductivity of air enclosed in these cylinders in and about Toronto, and has found that the conductivity of the enclosed air varied considerably with the character of the soil and rocks in the neighbourhood of the points of observation.

In making measurements on the ice above the water of Lake Ontario, the conductivity was found to be very much lower over the surface of the water than at points on the land on either side of the lake at some distance from the shore. In these experiments on the ice the values 8·6, 6·0, and 6·55 ions per c.c. per second were found for q with cylinders of lead, zinc, and aluminium respectively, and in a more extended series of observations with the lead cylinder alone, the conductivity was found to be the same over water with depths varying from 2·5 to 10 metres. Measurements were also made on board the steamer *Corona* during one of her passages over the lake, and values were obtained for q uniformly lower by approximately 6 ions per c.c. per second than those found in the laboratory at Toronto, although the depth of the water at the wharf in Toronto, where the observations in this series were commenced, was not more than 6 or 7 metres, while it was approximately 150 metres in depth at the deepest point on the line of passage.

Observations made on a sand bar extending out into the lake near Toronto gave a value of 9 ions per c.c. per second for q, and others made on land, at some distance from the shore, at various points and over different soils, gave values ranging from 11·2 to 15 ions per c.c. per second.

From the investigation it would appear that the water of Lake Ontario, as well as the sand along the shore line, contains little, if any, radio-active materials, and consequently does not contribute any appreciable proportion of the penetrating radiation observed at points on the earth's surface.

It would appear, too, from the constancy of the observed drop in conductivity that the water of the lake completely screens off any radiation coming from the soil or rock beneath it. In order to confirm this view, some experiments were made on the absorbing power of the water for the γ rays from radium. Thirty milligrams of radium bromide were enclosed in a brass tube with walls about 1 cm. thick. This tube was laid on the ice, and the ionisation chamber placed 113 cm. above it. With this arrangement it was found that the conductivity added by the radium bromide corresponded to the generation in the air in the chamber of 4485 ions per c.c. per second. A hole was then made in the ice, and the tube was lowered to different depths in the water beneath, the conductivity being measured for each position of the radium. At a distance of half a metre below the surface the conductivity corresponded to the production of 447·2 ions per c.c. per second, at 1 metre to 16·11, at 2 metres to 0·69, and at 3 metres to 0·62 ions per c.c. per second. From these numbers it will be seen that a layer of water between 2 and 3 metres in thickness sufficed to absorb practically all the radiation issuing from the radium in the tube.

In view of these experiments and of those of Elster and Geitel, who observed a fall of 28 per cent. in the conductivity of air enclosed in an aluminium cylinder, on taking this cylinder from the surface of the earth to the bottom of a mine surrounded with a wall of rock salt, it would seem that the penetrating radiation observed by a number of investigators at the surface of the earth is more or less local in character, and that, while its existence may be traceable to active substances present in the soil and rocks, the effective intensity is largely determined by the amount of inactive substances it may have to pass through in order to reach the surface.

The extremely low values found for q with the cylinders of lead, zinc, and aluminium in the experiments on the ice are interesting on account of their uniformity. They are, as is evident, of the order of magnitude of effects which might easily be accounted for by active impurities in the metals, since differences as large as these values of q may easily be obtained with cylinders made from different samples of almost any metal selected at random. Considering also the difference in the atomic weights of the three substances aluminium, zinc, and lead, and having in mind that radio-activity is a property associated with atomic structure, it would seem that if these metals could be obtained entirely free from active impurities, and the conductivity of air contained in vessels made from them studied, it would be found, if the observations were carried out under conditions or in places where no ionisation was possible from penetrating radiations arising from external sources, to drop to a very low value, if it did not entirely vanish.

The experiments described in this note were made with one of Mr. C. T. R. Wilson's latest type of gold-leaf electrometers, which was found, on account of its portability, and of the facility and exactness with which readings could be made with it, to be most admirably suited to the purposes of the investigation.

J. C. MCLENNAN.

Physical Laboratory, University of Toronto, March 30.

The Theory of Dispersion and Spectrum Series.

ON p. 413 of NATURE (March 5) Prof. Schott attempts to show that there is an irreconcilable inconsistency between Drude's dispersion formula and Balmer's formula for the lines in the hydrogen spectrum. I imagined that someone who could speak with greater authority than myself would make the obvious reply, but since no such reply has been forthcoming, and the arguments have been republished in another journal, I venture to ask for space to point out why they appear to me fallacious.

Prof. Schott's error consists in assuming that the λ_k in Drude's formula is the same as the λ_k in Balmer's formula. The λ_k in Drude's formula is the wave-length of the light for which the medium shows selective absorption; that in Balmer's formula is the wave-length of the light emitted by the gas when in a luminous state. An unintelligent

application of Kirchhoff's law sometimes leads students to imagine that the two quantities are identical, but Kirchhoff's law applies only to purely thermal radiation (*cf.* Wood's "Physical Optics," chapter xix.). A gas, such as hydrogen, in its non-luminous condition does not absorb selectively the light emitted by luminous hydrogen. I do not think that any absorption bands in non-luminous hydrogen have been detected; they are probably far in the ultra-violet, and there is no reason for supposing that their wave-lengths will be connected by any formula similar to that of Balmer.

The reason for the difference in the frequencies of the absorption bands and the lines in the emission spectrum is sufficiently obvious. The emission of light by a gas is doubtless connected with the ionisation of its atoms. But, when an atom is ionised, the electrons in or surrounding that atom are subject to forces entirely different from those which act upon them when the atom is ionised; there must be a corresponding difference in the periods of free vibration. The absorption bands probably represent the vibrations of the electrons in the neutral atom, the emission spectrum those of the electrons in or around the ionised atom.

Nor is there any reason why the refractive index of a *luminous* gas should differ greatly from that of a non-luminous gas, except in the immediate neighbourhood of a line in the emission spectrum. (It is relevant to note that Drude's formula cannot be applied to such regions.) Only a very small proportion of the total number of atoms present is ionised even under the most favourable experimental conditions; most of the atoms are not ionised, and affect the light in the same way as those of a non-luminous gas. Of course, if the refractive index due to the luminous atoms were really infinite, the refractive index of the luminous gas would be infinite, however small the proportion of luminous atoms. But it is impossible that it should be infinite; if Balmer's formula were accurately true for all values of m, there would be an infinite number of lines in the emission spectrum, implying an infinite number of degrees of freedom in the vibrating system. According to the modern view, which seems to be accepted by Prof. Schott, this system is composed of discrete charged particles possessing a finite mass; the number of such particles must be finite, and they can only have a finite number of degrees of freedom. Experiment can never demand an infinite number of lines, for, if m is very great, the lines are so close as to be beyond the range of resolution.

NORMAN R. CAMPBELL.

Trinity College, Cambridge.

The Oligochætous Fauna of Lake Birket el Qurun and Lake Nyassa.

IN NATURE of August 1, 1907 (vol. lxxvi., p. 316), Messrs. Cunnington and C. L. Boulenger wrote a preliminary account of the fauna of Lake Birket el Qurun. I am indebted to these gentlemen for the opportunity of supplementing their account by a note upon the Oligochæta of that lake. They were so good as to send to me two tubes with a large number of specimens of a small oligochætous worm collected in the lake. These specimens were found to belong, without exception, to the species *Paranais littoralis*. The occurrence of this Naid in northern Africa is a new fact in its distribution. It has hitherto been met with in many parts of Europe, both in fresh water and in brackish, even salt, water. As to its marine habitat, it has been collected on the shores of Denmark and near Odessa.

It is clear from the fact that this was the only aquatic Oligochæte met with by Messrs. Cunnington and Boulenger that it must at least be a prevalent form in the lake.

Mr. Cunnington has also kindly placed in my hands some examples of aquatic Oligochæta from Lake Nyassa. These belong to three species, and the contrast with the oligochætous fauna of the North African lake is very marked. The genera represented in Nyassa are Dero, Nais, and Pristina. Unfortunately, none of the examples submitted to me are sexually mature. The Pristina I identify with *Pristina longiseta*, a widely spread form. The genera Nais and Dero are also found in many parts of the world, and as all three genera have already been recorded from tropical East Africa (Michaelsen in *Zeitschr. f. wiss. Zool.*, Bd. lxxxii., 1905, p. 289), there is no cause for surprise at their occurrence in Nyassa. Still, the fact seemed to me to be worth putting on record.

FRANK E. BEDDARD.

Zoological Society's Gardens.

THE FORTHCOMING DUBLIN MEETING OF THE BRITISH ASSOCIATION.

THE British Association will hold its fourth meeting in Dublin on September 2–8 of this year. The three previous meetings took place in 1835, in 1857, and in 1878. The 1878 meeting drew an attendance of 2578, which was well above the average, and it was marked by the presence of an unusually large number of men distinguished in scientific or other work at the time and since. In his presidential address before the Anthropology Section, Prof. Huxley spoke prophetically about those "who may be here thirty years hence—I certainly shall not be," little realising how both his prophecies were destined to come true.

Appropriately enough (though, I believe, not consciously in connection with Huxley's forecast), the invitation for 1908 originated with Prof. W. H. Thompson, of the physiological laboratory of Dublin University. It was originally intended for 1907, but 1908 was found to be more suitable, and the invitation was formally accepted at York in 1906, where a deputation attended consisting of the Provost of Trinity College, Prof. Thompson, Dr. Tarleton, Monsignor Molloy, Rev. Dr. Delaney, and the Lord Mayor of Dublin. The invitation was formally renewed at Leicester by Prof. Thompson, Rev. Dr. Delaney, and Sir Howard Grubb. At a first meeting at the Dublin Mansion House, general and executive committees were appointed, and these have been at work ever since, with the result that the arrangements are in an advanced state of preparation. Sub-committees were appointed to deal with finance, entertainments, hospitality, and the handbook respectively. The four local secretaries are Dr. Joseph McGrath, secretary of the Royal University, Prof. W. E. Thrift, Prof. W. H. Thompson, and Mr. John Mulligan, of the Hibernian Bank. About 3000*l.* has already been subscribed towards the expenses of the meeting. The reduced fare tickets will be available for a month, so as to include the excursions subsequent to the official meeting. Day excursions will be arranged during the week of the meeting to the Devil's Glen and Glendalough in county Wicklow, to Powerscourt Waterfall and the Dargle near Bray, to the Boyne Valley, and to the Shannon Lakes.

The presidential address will be delivered by Mr. Francis Darwin, F.R.S., on the evening of Wednesday, September 2, in the large hall of the Royal University. Here also will be delivered two of the evening discourses, one on "Halley's Comet," by Prof. H. H. Turner, F.R.S. (Friday, September 4), the other on "The Lessons of the Colorado Cañon," by Prof. W. M. Davis, of Harvard University (Monday, September 7). The third evening discourse will be delivered to operatives on Saturday, September 5. To this discourse ordinary members will not be admitted. The lecture hall has not yet been decided upon.

The serious work of the sections will, for the most part, be over each day by two o'clock, leaving the

afternoon, and those evenings on which discourses are not held, free for entertainments of a social kind. Of the latter, not a few are already promised, including garden-parties by their Excellencies the Lord Lieutenant and the Countess of Aberdeen, by Lord and Lady Ardilaun, and by the provost and senior fellows of Trinity College; evening receptions are also to be held by the Viscount and Viscountess Iveagh, by the Royal Dublin Society, and by the Royal Irish Academy. The Lord Mayor and Lady Mayoress will be "At Home" at the Mansion House, to members of the association, on the afternoon of the opening day of the meeting.

The work of the Dublin meeting will be transacted in twelve sections, which, with their respective presidents, are as follows:—Mathematical and Physical Science (Dr. W. N. Shaw, F.R.S.); Chemistry (Prof. F. S. Kipping, F.R.S.); Geology (Prof. J. Joly, F.R.S.); Zoology (Dr. S. F. Harmer, F.R.S.); Geography (Major E. H. Hills, R.E.); Economic Science and Statistics (Mr. W. M. Acworth); Subsection Agriculture (Sir Horace Plunkett, K.C.V.O., F.R.S.); Engineering (Mr. Dugald Clerk, F.R.S.); Anthropology (Prof. W. Ridgeway); Physiology (Dr. J. S. Haldane, F.R.S.; Botany (Dr. F. F. Blackman, F.R.S.); Educational Science (Prof. L. C. Miall, F.R.S.). To increase the general interest in the doings of the association, these sections have been distributed over various institutions in the city, the governing bodies of which have kindly undertaken to provide suitable accommodation. Thus, Trinity College, the Royal University, the Royal College of Science, University College, the Royal Colleges of Physicians and Surgeons, the Royal Irish Academy, and the Royal Dublin Society all vie with each other in this respect.

The reception room and administrative offices during the meeting will be located in Trinity College. Until then, offices for the local reception committee have been kindly provided at the Royal University by permission of the Senate.

The official handbook is being prepared by Mr. R. Lloyd Praeger (author of "Irish Topographical Botany") and Prof. Grenville A. J. Cole, under the auspices of the Handbook Committee. It will comprise sections on local geology, botany, zoology, history and archæology, commerce and industries, and the usual official information. Among the articles will be one on glacial phenomena, by Mr. J. R. Kilroe, and another on mineralogy, by Mr. H. J. Seymour, both of the Geological Survey. Mr. Nathaniel Colgan, author of "Flora of Co. Dublin" and one of the editors of "Cybele Hibernica," will deal with botanical subjects. The zoology section will be prepared by Prof. G. H. Carpenter, and will comprise an essay on Irish mammals, by Dr. Scharff; birds, by Mr. R. M. Barrington (author of "Migration of Birds"); and numerous other special articles.

The history and archæology of the district round Dublin will be in charge of Mr. C. Litton Falkiner, secretary to the council of the Royal Irish Academy, and Mr. Elrington Ball (author of "History of the "Flora of Co. Dublin" and one of the editors of Murray's "Guide to Ireland") will deal with the prehistoric and other antiquities of the Boyne Valley, including the famous tumuli of Knowth, Dowth, and Newgrange, and with Dublin churches. There will also be articles by Mr. J. Westropp on the mediæval and ecclesiastical antiquities of Dublin and Wicklow; by Count Plunkett, the new director of the Dublin Museum, on old Dublin houses; and by Dr. Cosgrave, on old views of Dublin.

Dublin possesses attractions which very few capital cities can rival. Situated in the centre of Dublin Bay, its beautiful and prosperous suburbs extend northwards on to the promontory of Howth and southwards to Kingstown, Dalkey, and the far-famed Bay of Killiney, which, closed in by the Wicklow Mountains, presents an aspect of unsurpassed beauty.

A somewhat unusual element of local colour will be given to this year's Dublin meeting by the large number of bilingual street name-plates and sign-posts (an outcome of the Gaelic revival), on which the historic names are given in both Irish and English character and spelling. The well-known cordiality and hospitality of the Irish people may be trusted to render this year's visit of the devotees of science one of particularly agreeable memories.

E. E. F.

THE SCIENCE COURT OF THE FRANCO-BRITISH EXHIBITION.

THE fact that pure science will take a recognised part in the scheme of the forthcoming Franco-British Exhibition, and that it is being assigned a court specially for this subject, has already been recorded in these columns. It is believed that this is the first large exhibition at which such distinct recognition of the claims of pure science has been made, and it may be welcomed as being an example which should be followed at all future exhibitions.

The scheme of the court has been arranged so as to show apparatus and processes of historical value in the various sciences, and also, so far as possible, to illustrate various researches in science, both in the laboratory and in the factory, which have been and are being carried on. The exhibits will be arranged under the head of each of the great sciences, with subdivisions where necessary. Arrangements have also been made to illustrate the nature of the scientific work which is being carried on under the head of the exploration of the heavens, the air, the sea, and the land, which come naturally under the sciences of astronomy, meteorology, oceanography, geography, and geology. In this way it is hoped that a fairly complete review of all the important sciences will be obtained.

In the previous article in NATURE, the constitution and names of the full committee and of the various subcommittees were given. The preliminary arrangements and discussion of the principles to be followed, and the nature of exhibits to be asked for, occupied the committee several months, but the work of actually collecting the exhibits in each science which are to be shown was handed over by the committee to the various subcommittees and their respective Conveners, as they are the best and most appropriate judges of what exhibits are available. These subcommittees and their Conveners have really had a hard and difficult task in making representative and interesting collections, but they have, on the whole, been most successful.

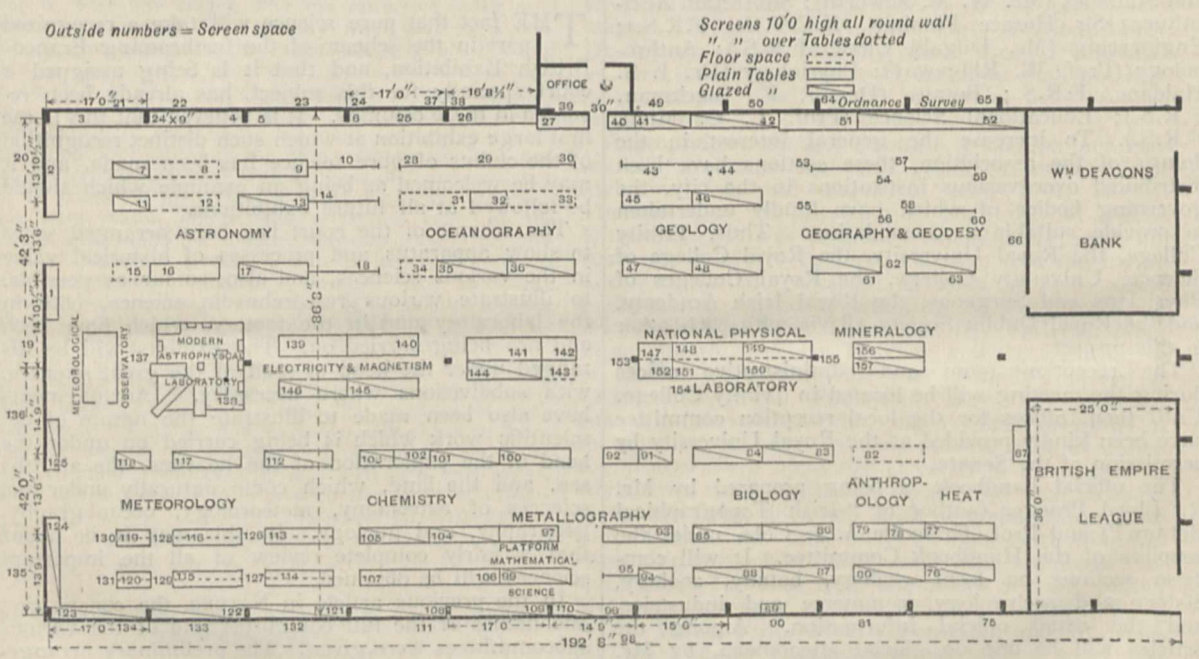
The usual difficulties in securing historically valuable apparatus have been experienced, and many individuals and institutions have not found themselves able to allow such apparatus to pass out of their own custody. Further difficulties have also arisen, as is usual in such cases, in the matter of space and funds, for both have had to be provided by the exhibition itself, as no public funds have been forthcoming. The executive committee has generously given a court, comprising the space of about 14,000 square feet, free of cost, for the science exhibits, and has placed at the disposal of the science committee

sufficient funds to allow the exhibits to be safely kept and properly displayed, though perhaps the exhibits will not be shown in such lavish surroundings as might have been desired.

The arrangement of the court is shown in the sketch-plan here reproduced. The north side of the court will be mainly devoted to "Exploration," and there will be a section devoted to astronomy which will have amongst its exhibits a very complete astrophysical observatory. The other sections in this part will be devoted to oceanography, geology, and geography.

In the centre of the court there will be most interesting exhibits from the National Physical Laboratory, also in electricity and magnetism, and in mineralogy and crystallography. The south side of the court will contain the meteorological exhibits, with a typical meteorological observatory, a large exhibit in chemistry, one of metallography, one of biology, one of anthropology, and one of heat, together with smaller exhibits of mathematical science and visible and invisible radiations.

It is also hoped that a meteorological observatory actually at work will be arranged in the grounds of the exhibition.



Franco-British Exhibition. Setting-out of Science Section. Building No. 11.

THE SCIENTIFIC STUDY OF STARVATION.[1]

TO the non-scientific mind the detailed study of inanition or starvation in men and animals may appear both useless and unnecessary. It is in reality one of the most important pieces of work the investigator of nutrition and allied problems can undertake. In the normal condition the processes of construction (anabolism) and decay (katabolism) are taking place simultaneously, and one can in that condition only obtain the net result of, or balance between, these two antagonistic phenomena. In order to understand the way in which the body builds itself up, it is obviously necessary that we should first know the amount and kind of the breakdown which accompanies vital activity, and so logically the study of katabolism must come first. This is only possible when anabolism is minimal; hence arises the importance of the knowledge of what occurs when the intake is limited to oxygen and water.

The work just published under the auspices of Dr. Benedict, the director of the Nutrition Laboratory at Boston, U.S.A., deals with this subject in a masterly way. It is a monument of prolonged and patient industry and self-sacrifice, as well as of admirably planned experiments on a large scale under careful and coordinated guidance. The book is not one which would be selected as a companion for a railway journey. It consists mainly of the protocols of the experiments, their ultimate valuation, and the general results to be drawn from them being left for the future.

A good deal of inanition work has been done in the past upon animals with useful results; a few observations have been made upon men, especially upon professional fasters. In order to obtain trustworthy averages, it is necessary that such experiments should be performed upon a large number of individuals, and this is the work which Dr. Benedict has, with the assistance of his colleagues, and the voluntary self-abnegation of a number of students and others, been successful in accomplishing. Experiments on man himself are more valuable than experiments on the lower animals in such a subject as this.

During Dr. Benedict's long association with the late Dr. Atwater, the celebrated respiration calorimeter was evolved, and the generosity of the Carnegie Institution of Washington has enabled now a special laboratory, situated in Boston, to be entirely devoted to work of this kind. English workers may well envy their more fortunate colleagues across the Atlantic in the ease with which funds are obtained both for higher education and research.

Each man who entered the calorimeter chamber was almost entirely shut off from the world for periods of two, three, and, in some cases, more days. His sole connection with his fellows was a telephone; he

[1] "The Influence of Inanition on Metabolism." By Francis Gano Benedict. Pp. v+542. (Washington: Carnegie Institution, 1907.)

could read, move about to some extent, and sleep for prescribed periods. But his every action was watched through a window and recorded. There were no meals to help him pass the time, and the principal occupation of the prisoner was counting his pulse, and respiration, and carefully collecting his excreta at frequent intervals. These were subsequently analysed, and their various constituents estimated. At the same time, the amount of oxygen used, of carbonic acid and water exhaled, of heat produced, and other factors too numerous even to catalogue, were all determined and recorded. One striking outcome of the work was that in the diaries reproduced comparatively little suffering apart from ennui was recorded. The same has been previously stated by professional fasters; we can therefore hardly doubt that in animals also the actual suffering has been small when they have been subjected to the withdrawal of solid food for a few days. The book is to be commended to all interested in physiological work, and especially to those engaged in a study of nutrition.

W. D. H.

RECENT PROGRESS OF THE METRIC SYSTEM.[1]

AN important report by Dr. Guillaume, presented at the meeting of the General Conference of Weights and Measures at Paris in October last, has recently reached us. Dr. Guillaume commences his report with an interesting account of some recent investigations which have been made at the International Bureau of Weights and Measures with respect to the permanency and invariability of the iridio-platinum standards of the metre and the kilogram, which were distributed in 1889 to the several States participating in the Metric Convention of May, 1875. The result of these researches is very satisfactory, and says much for the high standard of accuracy maintained in the metrological determinations of the bureau. Among other investigations which have been undertaken at the bureau since the previous meeting of the general conference in 1901, attention is directed to the work of MM. Benoît, Fabry and Perot in connection with the interferential measurement of light waves. The results obtained confirm in a remarkable manner the value found by Michelson and Benoît in 1892–3 for the length of the metre in terms of the wave-length (λ) of the red radiation of incandescent cadmium, in dry air at 760 mm. pressure, and at the temperature of 15° on the normal hydrogen scale. The new value, viz. :—

$$\text{Metre} = 1{,}553{,}164{\cdot}13\ \lambda,$$

leads to the following equivalent for the length of the yard, viz. :—

$$\text{Yard} = 1{,}420{,}212{\cdot}04\ \lambda.$$

These values differ from the earlier determination of Michelson and Benoît by less than one part in 10,000,000, from which it may be inferred that the interferential method of linear measurement can lay claim to a degree of accuracy far surpassing that attainable with the best micrometer microscopes.

Another important research, which has occupied the bureau for many years past and has now reached its final stage, is the determination of the weight of a given volume of pure water at its maximum density. From this investigation, which has been conducted principally by MM. Chappuis and Guillaume, the weight *in vacuo* of a cubic decimetre of water at 4° C. has been ascertained to be 0·999972 kilogram. As the weight of a gallon of water at 62° F., weighed against brass weights in air at the same temperature and with the barometer at 30 inches, is defined as being 10lb. avoirdupois, the following value for the cubic contents of the gallon may be readily deduced from the above result, viz. :—

$$\text{Gallon} = 277{\cdot}420 \text{ cubic inches.}$$

It follows that, under the same conditions of temperature and pressure as in the gallon equivalent,

1 cubic foot of water = 62·288 lb., and
1 cubic inch ,, = 252·325 grains.

Further investigations on the subject are in progress at the bureau, but it is unlikely that the final results will be found to differ appreciably from those given above. The values at present legalised in this country, which are based on determinations made by Kater in 1821, are far from accurate, but legislators are naturally chary of prescribing new relations between physical magnitudes before science has said her last word on the subject.

With respect to thermometry, researches undertaken at the bureau during the period covered by this report indicate that the normal scale of temperature adopted by the international committee in 1887 is practically in perfect agreement with the absolute thermometric scale. The corrections previously determined for reducing the readings of mercury thermometers to the latter scale are found to hold good even for instruments of the most recent construction. Formerly Tonnelot thermometers were employed at the bureau in metrological determinations, and thermometers of this type were supplied with the various national prototypes which were distributed in 1889. Of recent years preference has been given to instruments constructed by Baudin, which are subjected to a preliminary course of artificial heating in the vapour of sulphur. It has been found at the bureau that thermometers treated by this process acquire almost perfect stability.

Dr. Guillaume devotes one chapter of his report to recent legislation in different countries with respect to the metric system of weights and measures. During the last few years the metric prototypes of the bureau have been legally recognised in France and Roumania, and the laws of these countries have been brought into harmony with the present conditions of metrology. In Hungary a law was recently passed defining the units of force, pressure, and density in terms of the metric system. The legislature of Denmark has provided for the adoption of the system in that country by the year 1910. The system has also been made obligatory in the Portuguese colonies. On the other hand, Dr. Guillaume does not find much progress to record in Great Britain and its colonies or in the United States, so far as legislation is concerned. Canada has, however, with the acquiescence of the British Government, formally joined the Metric Convention on the footing of a separate State, and in New Zealand an ordinance has been passed prescribing the exclusive use of the system after an indefinite date.

A resolution of the general conference urging upon the various contracting States the formal adoption of a metric carat of 200 milligrams for use in the sale of diamonds and precious stones has been brought by the several Governments under the notice of the industry concerned. At present it is not possible to anticipate what response will be made by the trade. In this country the carat is not legally recognised, but as a customary weight its value is generally accepted as being 3·1683 grains, or 151½ carats to the

[1] "Les récents Progrès du Système métrique." By Ch.-Ed. Guillaume. Pp. 94. (Paris: Gauthier-Villars, 1907.)

ounce troy. This is equivalent to 205·3 milligrams. The carat is an extremely ancient weight, of uncertain origin so far as its present value is concerned, but it would appear to be in some way connected with the old standard of fineness for silver in England, viz., 10 oz. 2 dwt. of fine silver to the pound troy, this ratio of fineness being equivalent to the quotient of 64 grains by 24 carats.

In conclusion, it is pleasing to note the moderate tone and invariable accuracy of statement which characterise this report of Dr. Guillaume on a subject which is often discussed in print with considerable warmth.

NOTES.

A COMMITTEE has been appointed for the purpose of erecting a monument to Marcelin Berthelot by means of an international subscription. The president of the committee is M. Loubet, who is to be assisted, we learn from the *Revue scientifique*, by MM. Gaston Boissier, Léon Bourgeois, Darboux, and Levasseur. Donations may be sent to M. Ch. Goudchaux, 16 rue Miromesnil.

PROF. R. A. S. REDMAYNE, professor of mining in the University of Birmingham, has been appointed an Inspector of Mines, under the Coal Mines Regulation Acts, 1887 to 1905, the Metalliferous Mines Regulation Acts, 1872 and 1875, and the Quarries Act, 1894, under the title of "Chief Inspector of Mines."

THE death is announced, in his seventy-first year, of Prof. Leopold Schrötter von Kristelli, professor of internal medicine in the University of Vienna, and distinguished for his work in the science of laryngology.

THE management of the Municipal Exhibition, which will be opened at the Agricultural Hall on May 1, has arranged for an installation of Röntgen-ray apparatus in a special building in the hall, and for demonstrations, illustrating its use, to be carried out at certain hours each day.

WE learn from the *British Medical Journal* that the Riberi prize, of the value of 800*l*., which is given every five years by the Royal Academy of Medicine of Turin, has been awarded to Prof. Bartolomeo Gosio, director of the Laboratories of Public Health of the Italian Ministry of the Interior, for his studies on the bio-reaction of arsenic, selenium, and tellurium.

A BILL has been passed by the Virginia Legislature establishing a Virginia State Geological Survey. According to *Science*, the bureau is to have its headquarters at the University of Virginia, and the board is to be composed of the Governor (*ex officio*), the president of the University, the president of the Virginia Polytechnic Institute, and two citizens. An annual appropriation of 2000*l*. is provided

AN interesting exhibit of photographs, instruments, and other astronomical objects is now on view at Cardiff Museum. It was arranged by the Astronomical Society of Wales, and was opened by the Lord Mayor of Cardiff on April 23. Much interest is being taken in the exhibition, which will remain open for some weeks. The Cardiff City Council is now taking a commendable interest in the furtherance of popular astronomy, maintaining an observatory at Penylan Hill, which houses a 12-inch reflector. This observatory is also a meteorological station of the second class.

AN appeal is being made for subscriptions to a fund for the widow and daughters of the late Mr. Gerald Massey, whose literary works on subjects relating to myth, religion, and Egyptology are known to many readers and widely admired. A donation of 200*l*. has been received from the Royal Bounty Fund, and friends of the family have felt that this sum might form the nucleus of a fund which would yield a small income. Subscriptions will be received by Mr. James Robertson, 5 Granby Terrace, Hillhead, Glasgow, Scotland, who will render an account to all senders.

A CORRESPONDENT asks for information or references in regard to the deviation of rivers caused by the rotational velocity of the earth. Prof. G. A. J. Cole has kindly sent the following answer to the inquiry:—"The effect of the earth's rotation on the courses of rivers is regarded by many geographers as distinctly noticeable. The deflection is to the right in the northern hemisphere, the bank being, it is said, typically excavated on this side, while a shoal is left upon the other. In any series of meanders, therefore, those directed to the right side should tend to become more pronounced than those directed to the left. The reverse effects should occur in the southern hemisphere, the left bank being here eroded. Babinet and E. von Baer developed this theory in 1859 and 1860 respectively. The matter is discussed by G. K. Gilbert, *American Journal of Science*, vol. xxvii. (1884), pp. 427–32, and A. C. Baines, *ibid.*, vol. xxviii., pp. 434–6, and excellently and fully by A. Penck, 'Morphologie der Erdoberfläche' (1894), vol. i., pp. 351–60, with numerous references and examples; a sketch is also given by I. C. Russell, 'Rivers of North America,' Progressive Science Series (1898), pp. 39–43. F. Wahnschaffe, who has to deal with the great rivers moving in loose materials over the Prussian plain, throws doubt, like some other writers, upon the efficacy of the earth's rotation in producing a noticeable divergence by erosion ('Die Ursachen der Oberflächengestaltung des norddeutschen Flachlandes,' 1901, p. 188)."

THE general type of weather was very wintry and unsettled during the past week, and at many places in the northern portion of the kingdom a lower minimum temperature has occurred than has been previously recorded in April for about forty years, the shade readings ranging from 18° to 22°. Much snow has also fallen in all parts of the country. The report of the weather issued by the Meteorological Office for the week ending April 25 shows exceptional conditions for the time of year. The mean temperature had a deficit of 10° in the east of Scotland and in the Midland counties, and of about 9° in many other parts of the kingdom. The absolute minima were generally registered on April 24 or 25. At Balmoral the sheltered thermometer fell to 10° on April 24, whilst on the grass the reading was as low as 4°. On April 25 the highest reading throughout the day was 35°, at Oxford, and 34°, at Cullompton and Buxton. Nearly all the precipitation took the form of sleet or snow, and the fall was exceptionally heavy in the east and south of England. At Oxford the gauge yielded 1·66 inches for the twenty-four hours ending 8 a.m. on Sunday, the depth of snow being 16 inches, whilst at Southampton the depth was 14 inches, and at Marlborough 11 inches. At Bournemouth the snow which fell for twelve hours during Friday night yielded 1·13 inches of water, equal to about 11 inches of snow. The snowstorm on our south coast on Saturday, April 25, has been characterised as a blizzard.

WE welcome the formation of the Research Defence Society, the object of which is to make known the facts as to experiments on animals in this country. The society was formed in January last, and already numbers more

than 800 members. It is not an association of men of science or of medical men alone; its membership has been drawn from all departments of public life. Lord Cromer is the president, and a long list of vice-presidents includes the names of men distinguished in most branches of intellectual activity. The annual subscription is 5*s*., to cover working expenses, but larger subscriptions or donations will be gladly received. The acting honorary treasurer, *pro tem*., is Mr. J. Luard Pattisson, C.B., of the Lister Institute, and an account in the society's name has been opened with Messrs. Coutts and Co., 440 Strand. The honorary secretary is Mr. Stephen Paget, 70 Harley Street, London, W., to whom all communications should be addressed. Lord Cromer, in a letter which has been widely circulated in the Press, directs attention to the immense importance to the welfare of mankind of experiments on animals conducted with proper care, and instances, among many results which have already followed such investigations, the use of antiseptics, the modern treatment of wounds, the invention of diphtheria antitoxin, and the discovery of the causes of plague, cholera, typhoid fever, and sleeping sickness. He also explains that the society will endeavour to make it clear that scientific men who perform experiments on animals are not less humane than the rest of their countrymen who daily, though perhaps unconsciously, profit by them. It is proposed to give information to all inquirers, to publish *précis*, articles, and leaflets, to make arrangements for lectures, and to assist all who desire to examine the arguments on behalf of experiments on animals.

THE structure of the epidermis and epidermal glands of poisonous fishes forms the subject of an article by Mr. E. Pawlowsky in Nos. 7 and 8 of the *Comptes rendus de la Soc. Imp. Nat. de St. Pétersbourg* for 1907. In addition to the ordinary epidermal glands, poisonous fishes like the weavers (Trachinus) are furnished with large serous glands of a horny structure which secrete the harmful fluid. The sting-rays (Trygon) have, however, a numerous series of minute poison-glands in the tail.

RECENT papers received from America include an elaborate account of the early stages in the development of the Mississippi alligator, by Prof. A. M. Riese, issued in vol. li. of Smithsonian Miscellaneous Contributions, and illustrated with twenty-three plates. Also notes on Guatemala birds, by Mr. N. Dearborn, and on fishes from Mexico and Central America, by Mr. S. E. Meath, published by the Field Museum of Natural History. Schizopod crustaceans from Alaska form the subject of a paper by Mr. A. E. Ortmann, published as No. 1591 of the Proceedings of the U.S. National Museum; while in No. 1594 of the same, Mr. A. S. Pearse describes four new species of the amphipod group from the Gulf of Mexico, and in No. 1593 Miss Richardson records the occurrence of the parasitic isopod Leidya on an entirely new host.

THE first part of vol. vi. of the Annals of the South African Museum is devoted to a fourth instalment of the Rev. T. R. R. Stebbing's account of South African crustaceans, of which the earlier parts were published in "Marine Investigations in South Africa." In the present part the author describes as new seven species and one genus, but he takes occasion to point out that the most interesting results of his investigations are not so much novelty of characters in the new forms as the relationship between these South African types and others long known from remote parts of the globe. As an instance of this, it is mentioned that the description of the new Cape prawn, *Leontocaris paulsoni*, had only been published a few months when the discovery of a second species of the same specialised genus was announced in deep water off the Irish coast. The paper is illustrated by fourteen plates.

FROM the morphological standpoint, the rodent mammals form an exceedingly compact and uniform group. From the occurrence of the phenomenon known as inversion it has been suggested, however, that, developmentally, the murine section (Myomorpha) should be associated with the Subungulata, while the squirrel and hare groups (Sciuromorpha and Lagomorpha), in which inversion is absent, should constitute a section or order apart. On the other hand, it has been asserted that inversion, although most developed in the Myomorpha and Subungulata, does also occur in the other two groups, and the suggestion has been made that all rodents agree in their early developmental stages, although divergence takes place later. To test this, Mr. A. Ochs, of Düsseldorf, has undertaken an investigation of the intra-uterine development of the hamster, the results of which are published in vol. lxxxix., part ii., of the *Zeitschrift für wissenschaftliche Zoologie*. The conclusions with regard to the classification of rodents are, however, deferred.

ONE of the latest additions to the admirable series of "Guide-books" issued by the natural history branch of the British Museum is devoted to the elephant group, and explains in precise and yet popular language the wonderful story of proboscidean evolution revealed by recent discoveries in Egypt. The publication of such a guide-book was rendered practically imperative owing to the fact that the collection of proboscidean remains in the museum is more extensive than any other in the world. So large and so nearly complete is the collection that it is possible for the visitor to see with his own eyes practically every link in the chain between the primitive Egyptian Mœritherium, on the one hand, and the highly specialised Indian elephant and mammoth on the other. In the case of several of the early forms, complete models of the skull have been recently installed in the geological department. The interest of the series would be greatly increased if a life-sized model of the head of the long-chinned, four-tusked mastodon (*Tetrabelodon angustidens*) were prepared and placed alongside the heads of modern elephants. The guide, which is admirably illustrated, has been prepared by Dr. C. W. Andrews, the great authority on the group.

A PAMPHLET on the preparation and use of anti-plague vaccine has been issued by the Bombay Bacteriological Laboratory. It gives details of the preparation of the vaccine, and full directions as to the mode of inoculation. Another pamphlet on the same subject, "The Cause and Prevention of the Spread of Plague in India," a lecture delivered by Captain Glen Liston, summarises in a complete and interesting manner our knowledge of the parts played by the rat and flea in the dissemination of plague.

THE first part has reached us of a new publication, *Parasitology*, a supplement to the *Journal of Hygiene*, edited by Prof. Nuttall, F.R.S., and Mr. A. E. Shipley, F.R.S. *Parasitology* will include papers dealing with the anatomy of mosquitoes, fleas, protozoa, and other parasites, which have only an indirect relation to hygiene and preventive medicine. The present part is devoted to a paper by Dr. Karl Jordan and the Hon. N. C. Rothschild on a revision of the non-combed, eyed Siphonaptera, a group of fleas to which that carrying plague belongs.

THE March number of the Journal of the Royal Sanitary Institute (xxix., No. 2) contains an important paper by Dr. Rideal on the relative hygienic values of gas and

electric lighting. The principal conclusions are that, owing to the better ventilation obtained by gas, the products of combustion are not present in the air in anything like the proportion that might be expected, the temperature and humidity in an occupied room being no greater than when the room is lighted with electric light; that carbonic acid has not the injurious effects formerly attributed to it; and that products—heat, carbonic acid, and moisture—are derived from the inmates more than from the illuminant.

THE work of improving the sugar-cane is still going on at Barbadoes, and the results obtained during the season 1905–7 are recorded in a publication recently issued by the Imperial Department of Agriculture for the West Indies. One of the new canes yielded as much as 2000 pounds of saccharose per acre more than was obtained from the ordinary White Transparent; it is obvious that differences of this kind are of prime importance to the sugar planter. Manurial experiments are also recorded; these are intended to find profitable combinations of manures. One result is rather interesting; nitrate of soda gave a larger yield of sugar than sulphate of ammonia, although the latter is commonly preferred in the West Indies.

IN the *Indian Forester* (February) prominence is given to an article by Prof. M. Henry on forests and rainfall. A theoretical discussion of the argument that the atmosphere contains more moisture in the neighbourhood of forests is clinched by the observation of an officer of engineers that a balloon will descend when passing over an extensive wooded area. It is also indicated how forests increase the rainfall of a locality and help to augment the supply of water from springs. A native apparatus for distilling camphor oil from the leaves of *Cinnamomum Tamala* is illustrated by Mr. B. Gopaliah.

THE sixth number of the Quarterly Journal of the Liverpool Institute of Commercial Research in the Tropics (January) has been received. Dr. E. Drabble contributes several short articles on West African oil seeds, dealing with *Carapa procera, Poga oleosa; Irvingia gabonensis*, the source of Dika butter, and *Scyphocephalium Kombo*; also a comparison of the barks of the red (*Rhizophora mangle*) and the white mangroves (*Laguncularia racemosa*) from the same region. Mr. R. Newstead furnishes the identifications and descriptions of several coccids infesting plants in Madagascar, among them being the gum-lac insect, *Gascardia madagascariensis*, that is allied to Ceroplastes, but is very different from Tachardia, the Indian lac insect. In connection with analyses of latex from *Ficus Vogelii*, Dr. D. Spence directs attention to the high percentage of magnesium and chlorides contained, as compared with the latex of Hevea or Funtumia, in which phosphates are largely present, while chlorides are almost absent.

A SECOND paper dealing with the fern genus Nephrodium is communicated by Mr. S. Yamanouchi to the March number of the *Botanical Gazette*. It is concerned with spermatogenesis, oogenesis, and fertilisation in the genus as exemplified in the species *Nephrodium molle*. The author obtained a very complete set of stages in the development of the spermatozoid. Blepharoplasts, arising in the cytoplasm, were observed in the sperm mother cell. The important modification of this body occurs in the sperm cell when it flattens out above the nucleus, becomes band-shaped, and finally wedge-shaped, with the narrow end joined to the nucleus. Thus the anterior part of the sperm is formed from the blepharoplast. The development of the ovum is normal; in fertilisation the sperm remains unchanged for a period after entering the egg nucleus, but eventually disintegrates with the formation of a reticular structure, and mixes with the egg nucleus.

BULLETIN No. 14 of the Edinburgh and East of Scotland College of Agriculture contains a detailed statement of the yield of milk and the percentage of fat therein obtained from a herd of twenty-seven cows. The fact that cows vary considerably in their milk yield is clearly brought out, and farmers are urged to keep systematic records of each cow's yield in order to improve the general standard by eliminating the poor ones.

No. 6 of the Memoirs of the Department of Agriculture in India deals with the movements of water in the soil. Perhaps no subject is of more importance to the agriculturist, or so little investigated in Great Britain and the British dependencies. Dr. Leather furnishes an interesting set of measurements which will prove of great value if they succeed in attracting some competent physicist to direct his attention to the numerous physical problems awaiting investigation in agricultural science.

THE February number of the *Agricultural Journal of the Cape of Good Hope* contains a report on the suitability of various South African fibre plants for paper-making. Four materials are discussed, matjesgoed fibre, palmiet fibre, papkuil fibre, and bamboo; samples of the first three sent over to the South African Products Exhibition in London yielded pulp valued at 6*l*. or 7*l*. per ton, whilst bamboo pulp is valued at 9*l*. to 10*l*. In view of the abundance of fibre material in Cape Colony for which no use at present exists, the possibility of preparing pulp on the spot, and either exporting it or making it into paper, seems worthy of very careful consideration.

A NEW national forest, named the Verde, and consisting of 721,780 acres, has just been created, says the *Scientific American*, in Maricopa and Yavapai counties, Arizona. The forest lies on the west side of the Verde River, and constitutes a great part of its watershed. Most of the reserve is covered with brush that has no commercial value, but a small part has merchantable timber on it. The protection of the brush-grown area is just as important as that of heavily forested land, the scrub being the only thing that conserves the water and saves the watershed of the Verde River from erosion.

IN the *Mitteilungen* from German protectorates (vol. xxi., part i.), Dr. P. Heidke continues the discussion of meteorological observations made at Windhuk (South-West Africa) for the year ending June, 1906, commenced in the previous volume of this publication, dealing with the daily range of air-pressure and temperature and with their harmonic constituents. The effect of the continental climate is well shown in the small night minimum and evening maximum of pressure, as compared with the large morning maximum and afternoon minimum. The same number contains a valuable compilation, also by Dr. Heidke, of the monthly and yearly results, together with harmonic constituents, for twenty-five stations in the East African Protectorate, for the years 1903–4, deduced from tri-daily observations. References are also given to the periodicals in which the observations for previous years are published.

IT is stated in *Engineering* of April 24 that H.M.S. *Tartar*, the turbine topedo-boat destroyer, has satisfactorily undergone a very severe series of trials, and has been taken into commission. The *Tartar* is the fastest warship afloat, its speed on the official trials being 35·672 knots as a mean of six runs. During six hours' run the mean speed proved to be 35·363 knots, while the fastest run was

at the rate of more than 37 knots. The speed guaranteed by contract was 33 knots. The vessel is 270 feet long, the propelling machinery being Parsons turbines and six Thornycroft water-tube boilers.

THERE has been much controversy in recent years on the subject of that class of Palæolithic stone implements which have been called eoliths. The question has now been taken up in the April number of *Man* by Mr. Worthington Smith, who deals specially with discoveries in the North Herts and South Beds plateaux, and in particular with the contorted drift, which contains all the varieties of worked stones which were lying on its surface at the time of its deposition, including older and newer palæoliths and their ever-accompanying eoliths. The last class he thus attempts to define:—"At the present day all kinds of oddities in flint are passed off as 'eoliths'; one author says the examples must be bulbless; another describes well-formed bulbs. One says the secondary flaking is vertical; another that it is lateral. Sometimes a proof of authenticity is said to rest on the fact that the stones in question present no flaking at all, only rubbing. If museums are visited one sees ordinary palæoliths masquerading as 'eoliths,' and rubbing shoulders with minor well-known Palæolithic forms, iron-stained neoliths, surface flints, and late Victorian oddities of all sorts." In short, Mr. Smith concludes that there are no such things as "eoliths" at all, nine out of ten of the thousands sent to him for examination being only natural flint fragments. "The tenth has been a minor and well-known Palæolithic form, or, it may be, a bulbed, iron-stained, Victorian flake, knocked off by the hoof of a farm animal." None of those he has examined he believes to be as old as the Boulder Clay.

IN a recently issued pamphlet ("Plato or Protagoras?" London: Simpkin, Marshall and Co., price 1*s.* net) Dr. F. C. S. Schiller propounds a novel and interesting view of the real significance of the speech attributed to Protagoras in Plato's dialogue, "Theaetetus." According to this view, the argument of the speech was not invented by Plato, but represents an attempt on his part to state fairly the actual case of an opponent whom he had not completely understood, and who had at the time of the composition of the dialogue passed beyond the reach of interrogation. Dr. Schiller seeks to justify his interpretation by maintaining that the criticisms which are directed by "Socrates" against the Sophist's arguments do not really refute them, and, in fact, prove merely that Plato had formed a very imperfect conception of their meaning and scope. Incidentally, Dr. Schiller takes occasion to claim that Protagoras was in all essential points an early exponent of his own doctrine of humanism, and that Plato's failure to refute him was prophetic of the superiority of the pragmatic philosophy over all forms of "intellectualism."

THE *American Journal of Science* for April contains an article by Mr. H. M. Dadourian, of Yale, on the constituents of atmospheric radio-activity at New Haven. Mr. Dadourian suspended a negatively charged wire for three hours in a cavity in the ground, and another for four days in the air about 7 metres above the ground. On determining the rate of decay of the radio-activity of each wire, he found that 5 per cent. of the initial radio-activity of the first, and 20 per cent. to 30 per cent. of that of the second, was due to thorium and its products, the rest to radium and its products. From this he deduces that the amount of radium emanation present in the air of New Haven is about 40,000 times as great as the amount of thorium emanation.

THE Adamson lecture, founded in 1903 in memory of the late Prof. Robert Adamson, of Manchester, was delivered last term by Prof. J. J. Thomson, and has recently been published by the Manchester University Press. It deals with the relation between ether and matter brought to light by recent electrical investigations. Prof. Thomson points out that in electrical phenomena we are brought into contact with cases of interaction between bodies charged with electricity, in which the action of the first on the second is not equal and opposite to the reaction of the second on the first. In such cases we suppose that both bodies are connected with the ether around them, and that Newton's third law holds when we consider the ether and the two bodies as constituting the system under examination. From this point of view, the potential energy of an electrical system may be regarded as due to its connection with an invisible subsidiary system possessing kinetic energy equal in amount to the potential energy of the original system. This conception may be further extended to non-electrified bodies, and the ether thus comes to play an important part in ordinary dynamics.

PROF. ANDREW GRAY delivered an oration on Lord Kelvin at the University of Glasgow on Commemoration Day, April 22. The address dealt largely with the early work of the great master at Glasgow, when he was making the electrodynamic and electromagnetic theories more explicit, and testing them experimentally under conditions the antithesis of those which exist in the well-equipped laboratories of the present day. Prof. Gray mentions two views held by Lord Kelvin to which we may at the present time well devote special attention. He believed that the study of natural philosophy ought not to be excluded from the arts curriculum, and he was strongly opposed to the tendency which has been manifesting itself to separate the experimental from the mathematical side of physical work. With him the mathematical symbol was merely the servant of the idea, and mathematical methods had their place among the tools and instruments of research. The printed copy of the oration contains portraits of Lord Kelvin in 1846, 1868, and 1905 respectively, and a view of the outside of the natural philosophy rooms of the old college buildings.

PROF. P. ZEEMAN, in his second note on the magnetic resolution of spectral lines and magnetic force (*Koninк. Akad. Wetens. Amsterdam*, December 24, 1907), gives some striking measurements of asymmetric separation, with excellent photographic reproductions illustrating the various stages. By means of the method of the non-uniform magnetic field, described in the first article in the above Proceedings for April, 1907, he finds it possible to study at a glance any series of phenomena dependent on the field intensity for a series of different intensities. The class of asymmetric separations herein considered has been predicted from theory by Voigt, and has also been considered by Lorentz. One of the most interesting cases is the yellow mercury line at λ 5791, the structure of which cannot be satisfactorily made out by the interferometer. The first-order spectrum of a Rowland concave grating of 6·5 metres radius, with 10,000 lines to the inch, has been employed for the investigation. It is seen that while the 5791 line is resolved asymmetrically, the neighbouring line, 5770, is resolved into a perfectly symmetrical triplet. Of this pair of lines a nine-fold enlargement of the original negative is given, showing most distinctly the above effect. The intensity of the magnetic fields employed varied from 14,800 to 29,220 Gaussian units. There are several points requiring further

investigation; the apparent inconstancy of the amount of asymmetry contrary to theory, also the apparent asymmetric intensities observed in the components of various lines. Careful measurements of the width of the lines show that the mean value is about 0·07 Ångström unit, and that the asymmetry amounts to about half this amount.

SIR WILLIAM RAMSAY contributes to the May number of *Cassell's Magazine* a popular article under the title "How Discoveries are made," in which he refers, among other matters, to the work of Priestley, Scheele, and Cavendish on air and combustion; Crookes, Lenard, and Röntgen on kathode rays; and Soddy and himself on radium emanation and its decomposition into helium, leading up to a short statement as to β rays and the corpuscular theory of electricity. The article provides general readers with a glimpse of scientific work, and is a welcome feature in a popular magazine.

THE Institute of Chemistry has published a second edition of the "List of Official Chemical Appointments." It has been compiled by direction of the council of the institute, and under the supervision of the proceedings committee, by Mr. Richard B. Pilcher, registrar and secretary of the institute. The scheme adopted in the first edition has been adhered to, the information has been corrected carefully, and numerous additions, including an index of names, have been made. The list is arranged in two main divisions; the first contains appointments in the British Isles, and the second in India, Canada, Australia, British colonies and protectorates, Egypt, and the Sudan provinces. The appointments dealt with include those under State departments, local authorities, and public institutions, in addition to teaching posts at universities, colleges, and schools. An appendix gives concise information as to societies for the advancement of chemical science and of professional chemical interests. The publication, the price of which is 2*s.* net, should prove of great service to all who are interested in the applications of chemistry to State purposes and in the teaching of the science at its various stages.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY:—

May 1. 8h. 46m. to 12h. 28m. Transit of Jupiter's Sat. III. (Ganymede).
3. 21h. 59m. Venus in conjunction with the Moon. Venus 4° 15′ N.
4. 8h. 48m. to 9h. 46m. Moon occults μ Geminorum (mag. 3·2).
5. 0h. 51m. Neptune in conjunction with the Moon. Neptune 1° 20′ S.
6. 22h. 41m. Jupiter in conjunction with the Moon. Jupiter 1° 47′ S.
7. 10h. 56m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·388.
,, 8h. 42m. to 13h. 31m. Transit of Jupiter's Sat. IV. (Callisto).
16. 11h. 15m. to 12h. 22m. Moon occults ψ Ophiuchi (mag. 4·6).
19. 8h. 34m. Uranus in conjunction with the Moon. Uranus 0° 35′ N.
24. 23h. 47m. Saturn in conjunction with the Moon. Saturn 3° 15′ N.
29. Venus at maximum brilliancy.
30. 9h. 25m. Minimum of Algol (β Persei).
31. 13h. 52m. Mercury in conjunction with the Moon. Mercury 2° 19′ N.

A NEW STAR-FINDER.—The "Metron" star-finder submitted to our examination by the maker, Mr. C. Baker, 244 High Holborn, is an ingeniously designed instrument which will enable beginners in astronomy to become practically acquainted with the constellations and the brighter stars, and also with the more important problems usually placed under the heading "The Use of the Globes." It consists of a 4-inch celestial globe mounted on a tripod and stand so that it may be erected for any latitude. A date circle and a loose hour circle round the south pole enable the user to set the globe for any day and hour of the year. There is also a wire grip carrying a circle, with a pointer at its centre, and a pair of telescopic sights. Having set the globe for latitude, oriented it north and south by the fixed compass, and levelled the stand by means of the two bubbles set in it, the user sets the hour circle according to the directions, and places the pointer over the star, on the globe, which he wishes to locate and recognise; the real star may then be seen in the centre of the telescope field. In this way a number of constellations and important stars, of which the names are given on the globe, may be recognised. Conversely, knowing the date and the position of the star, the approximate time may be determined; special sights are supplied for work on the sun. To facilitate the reading of the globe and circles when working at night, a small electric lamp—and dry cell—is fitted to the stand.

The whole apparatus is nicely finished in nickel plate, and should prove useful in demonstrating problems in astronomy to beginners. For anything like accurate work, the apparatus in its present form and size is, we believe, on too small a scale; a very small error in the setting produces great confusion when magnified on the celestial vault, and the unaided beginner would probably find that his knowledge of the constellations was not considerably enlarged; when he began to be familiar with the instrument and the stars he would find in the combination a source of many hours of interesting work and problem-solving. Spare globes, covered with blank paper, may be obtained for the purpose of plotting the apparent paths of planets, &c.; on the present globe we notice one or two misspellings, *e.g.* Sygnus, Delphin, as the names of constellations. The price of the instrument, complete in box, is 2*l.* 12*s.* 6*d.*

SATURN'S RINGS.—In No. 4243 of the *Astronomische Nachrichten*, pp. 289 to 313 are devoted to records and discussions of observations of Saturn made by various observers during the end of 1907 and the beginning of the present year. Prof. Lowell and Mr. Lampland give the details of the Flagstaff observations, and the former discusses the appearance of the edge of the ring system and of the condensations remarked by Prof. Barnard, themselves, and other observers. When observing the shadow of the rings on the ball of the planet, all the Flagstaff observers noticed that it was traversed by a medial core the blackness of which was far more intense than that of the boundaries. This core was first observed on June 19, 1907, and was plainly visible on subsequent occasions; on November 5 the shadow generally was of a faint cherry-red tinge, and the black medial line was slightly undulatory, showing irregularities of outline. Drawing conclusions from the discussion of his results, Prof. Lowell finds that the rings approach more nearly to the body of the planet than hitherto measured, and that the middle and inner members of the ring systems are not flat rings, but tores; this would account for the condensations observed, and for the medial core of the shadow.

THE SYSTEMATIC MOTIONS OF THE STARS.—From the analytical study of the motions of 1100 stars having proper motions of between 20″ to 80″ per century, and distributed over both hemispheres, Prof. Dyson has obtained results which confirm those previously obtained by Kapteyn and Eddington, viz. that the stars are moving in two streams.

The positions found for the apices of the two streams as found by the different observers are shown below:—

	Stream I.	Stream II.
Kapteyn ...	R.A. 85°, Dec. −11°	R.A. 260°, Dec. −48°
Eddington ...	,, 90°, ,, −19°	,, 292°, ,, −58°
Dyson	,, 94°, ,, −7°	,, 240°, ,, −74°

The quick-moving stars considered in the latest discussion show the two distinct drifts very pronouncedly, particularly in the case of Stream II. For Stream I. the

three determinations agree within 7° of the position R.A.=90°, dec.=−12°, and for Stream II. within 14° of the position R.A.=263°, dec.=−60° (Proc. Roy. Soc. Edinburgh, vol. xxviii., part iii., No. 13, p. 231, February).

DETERMINATION OF THE ERRORS OF THE PARIS OBSERVATORY RÉSEAUX.—In a paper communicated to the Paris Academy of Sciences, M. Jules Baillaud describes a novel method whereby he has determined the errors of the *réseaux* used in connection with the *Carte du Ciel* plates at the Paris Observatory. By this method the influences of variations of temperature and of deformation of the gelatin film during development are eliminated, and M. Baillaud finds that the errors attain the value 3 μ, the variations between measures on several plates not exceeding 0·5 μ. This is of the same order of size as the grain of the plate used, and it would probably be possible to reduce the apparent discordance by using plates of a finer grain (*Comptes rendus*, No. 12, March 23, p. 616).

THE HERSCHELS' NEBULÆ.—No. 4, vol. ii., of the *Rivista di Astronomia* (Turin, April, p. 82) contains an article of especial interest and value by Madame Dorothea Isaac-Roberts, who discusses the nebulæ discovered by the Herschels as photographed by the late Dr. Isaac Roberts. The author first gives a brief review of the history of nebulæ observations from the time that Galileo discovered the first true nebula in 1610; then follows an explanation of the classification of nebulæ made by Sir William Herschel, and of the code used by Sir John Herschel in his descriptions of nebulæ. A brief description of the plates shown in the latter's memoir of 1833 is followed by a discussion of the groups of nebulous bodies as classified by Dr. Roberts. The paper concludes with a brief sketch of the lines which the author's discussion of Dr. Roberts's plates will follow, and is to be continued in the following number of the review.

HORIZON AND PRIME-VERTICAL CURVES FOR LATITUDES +30° TO +60°.—In these columns for January 30 (NATURE, No. 1996, p. 302) we described briefly a useful sun and planet chart submitted for our inspection by Messrs. Carl Zeiss. The same firm has now sent us a transparent celluloid scale, devised by Herr H. H. Kritzinger, which, when used in conjunction with the charts, enables one to see at a glance the relative positions of the local horizon and prime vertical for any place between latitudes 30° and 60° north. This allows the approximate sidereal time of rising and setting of the stars, and of their transit through the prime vertical, to be found at once, and with no trouble beyond that involved in superposing two sets of lines. Messrs. Zeiss will be pleased to send copies of this new scale on receiving applications.

EDUCATIONAL LEAKAGE.

THE success of any system of technical instruction or higher education depends ultimately upon the preparatory education of the students in our technical schools and other institutions of higher education. The results hitherto obtained from the work of colleges and technical schools in this country have been discounted seriously by the inadequacy in the nature and supply of the education for boys of school age. Mr. V. A. Mundella, in an address delivered last year to the Association of Teachers in Technical Institutions, directed attention to the subject, and also by means of curves illustrating recent statistics demonstrated the serious leakage of children at twelve and thirteen years of age, who afterwards receive no education whatever.

The accompanying diagram shows the number of children at stated ages, and the grade of education, if any, they are receiving. Mr. Mundella states that there are in England and Wales, between the ages of eleven and twelve years, 718,000 children, of whom 620,000 are in elementary schools, and at the outside 40,000 in public and private secondary schools. The curve T shows the total number of children at each year of age up to twenty-one years, and the curve A the total number of these children in elementary schools. The form of A shows strikingly the rapid decrease in school attendance between the thirteenth and fifteenth years. The curve *t* exhibits the number of children surviving, at each year of age, who have attended an elementary school, and a comparison of this curve with those marked B, C, X, shows how little has been accomplished in the direction of continuing the education of the nation's children after the elementary school has been left. Curve B illustrates the total number of children in science and art classes, C in evening continuation schools, X in secondary schools, and U—a continuation of X—in universities and university colleges. The curve X is based upon statistics published in 1898, no later statistics being available. The curve D represents the number of surviving

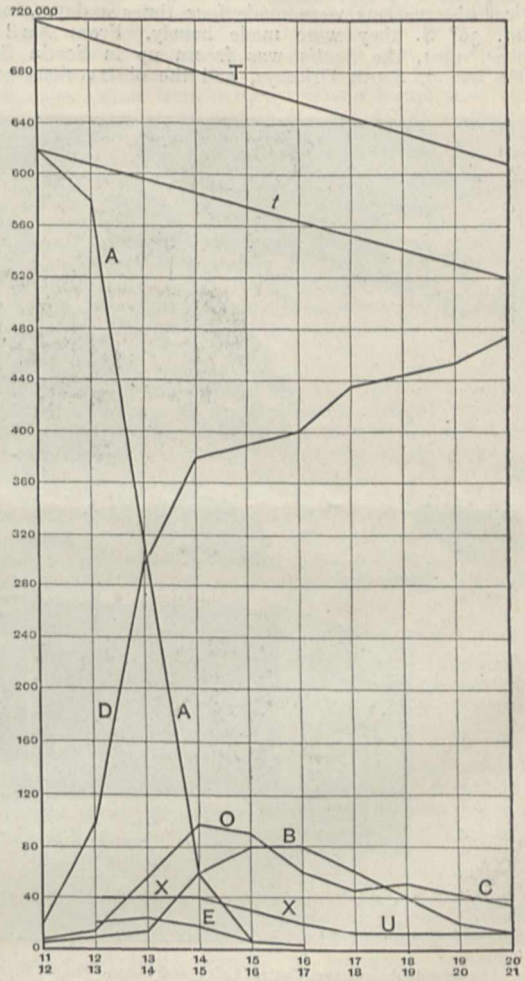


Diagram showing the number of young people in England and Wales between the ages of 11 and 21, and the number receiving education in schools and colleges of various types.

children who have attended elementary schools, but are receiving no further organised education, and E shows the total number of children at each age taking approved courses of instruction in State-aided secondary schools.

The facts embodied in this diagram demonstrate very clearly the need for strenuous national effort to insist upon children attending primary schools until they are fourteen years of age and abolish the present system of half-timers and other exemptions, to provide for continuation schools at which attendance shall be compulsory, and to establish secondary schools which are really schools of a high educational type. Schools in which 80 per cent. of the pupils leave at fifteen years of age or under are better described as higher elementary schools than as secondary schools, under which title they are at present classified.

THE SCIENTIFIC RESULTS OF THE VOYAGE OF THE S.Y. "SCOTIA."[1]

THE results of the meteorological, magnetical, and tidal observations made by the Scottish National Antarctic Expedition have now been published under the editorship of the leader, Dr. W. S. Bruce. This part of the work of the expedition was organised by Mr. R. C. Mossman.

The instrumental outfit was complete, well selected, and carefully standardised. Thus the barometers were compared with the Meteorological Office standard before and after the expedition, with the Argentine standard in January, 1904, with the Cape standard in May, 1904, and with the lighthouse barometer at the Falkland Islands.

Whilst at sea, and north of lat. 30° S., the meteorological observations were made four times a day. South of lat. 30° S. they were made hourly. From April to October, 1903, the *Scotia* was frozen up in Scotia Bay, Laurie Island, South Orkneys, and the observations were made on the ship. On November 1 the instruments were transferred to a stone hut which had been erected and called "Omond House." The observations were continued here while the ship went to Buenos Ayres to refit.

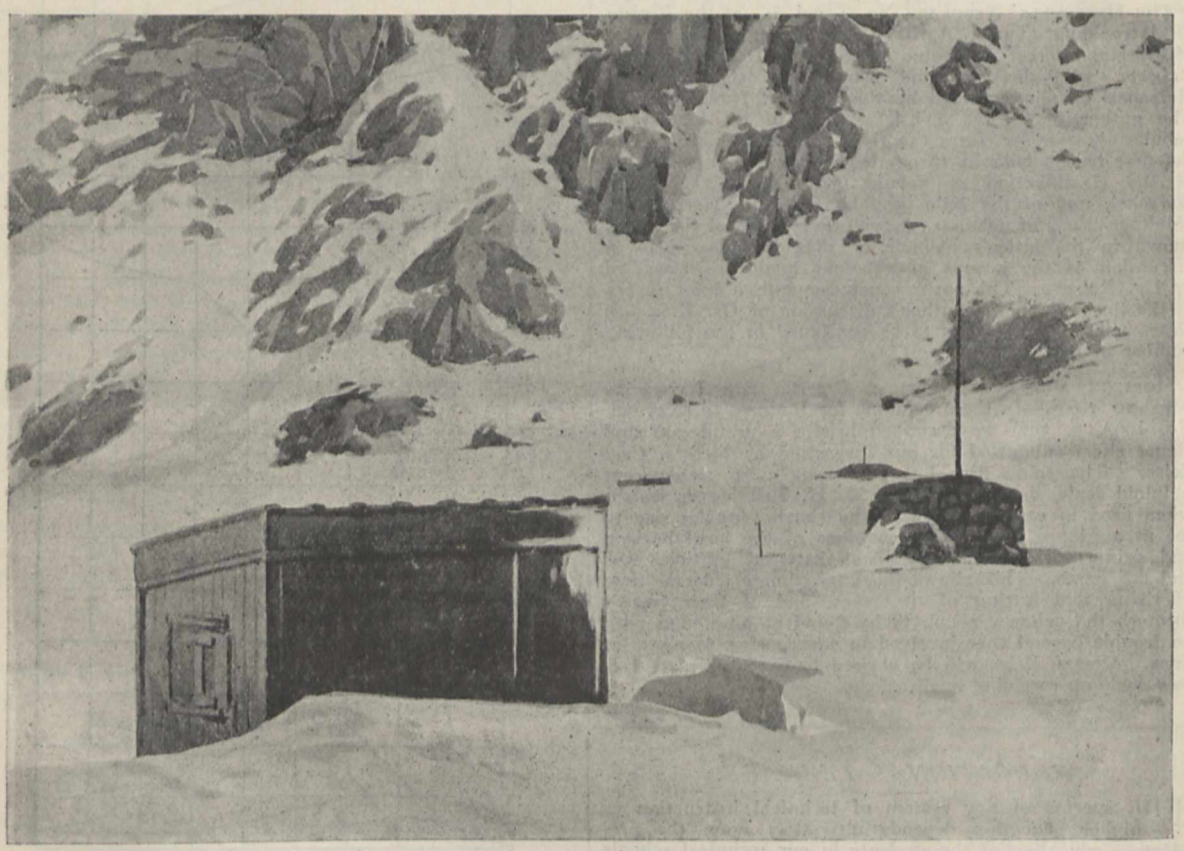
Besides the observations actually made by the staff of the expedition, the report also includes observations made at Cape Pembroke lighthouse. The *Scotia* took out to this lighthouse a number of instruments from the Meteorological Office, and the lighthouse keeper or his assistant made readings every four hours. The lighthouse was used by the *Scotia* as a base station.

In the discussion of the observations taken at sea, reference is made to the fact that it was necessary to have two sets of thermometers, one on each side of the ship, and to use the observations taken on that set which was to the windward, the heating effect of the ship fires being sufficient to cause those instruments on the leeward side to read one or two degrees too high.

During the summer cruise of 1902–3 the Weddell Sea was filled with pack ice as far north as lat. 60° S., whilst in the next summer the *Scotia* reached Coats Land, lat. 72° S., without meeting any obstacle.

Comparison of observations made in the Weddell Sea with those made at Snow Hill, Graham's Land, shows that in February and March the pressure and temperature are higher than at Snow Hill. The cloud amount is also high, for during 81 per cent. of the time during which observations were made the sky was overcast, and only 3 per cent. of the time cloudless.

The observations at the South Orkneys were under the direction of the Scottish expedition only eleven months (April, 1903, to February, 1904), and were continued under the auspices of the Argentine Republic. By permission of the Argentine meteorological director, Mr. Mossmann has been able to discuss observations taken during 1904, and records the mean temperature as 22°·7, the lowest reading being −26°, in June, 1903. The diurnal range of temperature varies from 1°·1 in autumn to 3°·2 in spring.



View of Copeland Observatory, Central Cairn, and Omond House, Scotia Bay. Reduced from a Report of the Scottish National Antarctic Expedition.

It was noted that, whereas on the eastern coast of Graham's Land the easterly winds are very conspicuous, the winds at Scotia Bay had only a very small easterly component.

As the expedition was not originally arranged with the intention of making magnetical observations, the only instruments taken were a portable magnetometer and a dip circle. There being no special non-magnetic area on the *Scotia*, no observations were made at sea.

A wooden hut erected not far from Omond House, and called the Copeland Observatory, was used to shelter these instruments. The observations were made under very adverse conditions. It was often found that the magneto-

[1] Scottish National Antarctic Expedition. Report on the Scientific Results of the Voyage of the S.Y. *Scotia* during the Years 1902, 1903, and 1904, under the leadership of W. S. Bruce. Vol. ii., Physics. Pp. xvi+324, Edinburgh: Scottish Oceanographical Laboratory, 1907.) Price 1*l.* 1*s.*

meter had become crusted with ice spicules, and it had to be thawed out before it could be used. Many other difficulties had to be encountered, and it is surprising that any successful observations were made; but Mr. Mossman, assisted by Mr. W. Martin, secured, besides other observations, hourly observations on twenty days.

The magnetic observations are discussed by Dr. Chree, F.R.S., who remarks that the results show how very carefully the observations were made. The observations extended over the period May, 1903, to February, 1904.

The following values are given:—declination, 5° 31′·2 east; inclination, 54° 30′·6 south; horizontal force, 0·25704; mean daily range of declination obtained from the hourly readings, 8′·65.

While the *Scotia* was anchored and frozen in Scotia Bay observations of the tide were made by means of a very simple gauge. A long wire, fastened to the sea floor by a heavy weight, passed over a pulley, and was kept taut by a lighter weight at the other end. As the ship rose and fell with the tide this weight moved up and down a vertical scale, which was observed half-hourly.

The tides seem to be normal for a place in the Southern Ocean. The semi-diurnal tides are considerable, but the solar tide is unusually large compared with the lunar tide, the ratio being three-fifths, or 0·6, as compared with 0·465 of the equilibrium theory. The semi-diurnal tides are almost exactly "inverted," so that low water occurs very nearly when the moon is on the meridian.

THE METEORS OF HALLEY'S COMET.

IN view of the approaching return of Halley's comet, the Aquarid meteor shower of May ought to be awaited with special interest. We know comparatively little of this system, as it has been seldom observed. It is certain, however, that it is the richest of our May showers, and that its radiant point conforms very nearly both in date and place with the radiant and epoch of particles following the path of Halley's comet. This circumstance alone is significant, and the supposed connection of the comet and meteoric display will be sure to receive ample investigation during the next few years.

The Aquarids should be looked for after 1 a.m. in the mornings between the end of April and May 7, and they are directed from a region at about 337°−2°, just below the equator. Lieut.-Colonel Tupman determined the radiant as about 10° west of the point assigned, and further observations are required to ascertain the exact place, and also the precise date of the maximum of the shower.

If really associated with Halley's comet, the meteors ought, in immediate ensuing years, greatly to increase in numbers, though we possess no historical records of rich showers having been observed in 1759 or 1835, when the comet previously returned to perihelion. But many meteoric phenomena have eluded recognition, and it is very possible that some returns of these Spring Aquarids may have escaped notice, as they are only visible just before sunrise, and were never specially looked for until after their discovery nearly forty years ago by Lieut.-Colonel Tupman. This stream, like the Perseids and Leonids and many other showers, is evidently one visible nearly every year, and forming a complete ellipse. It now remains for observations in immediately ensuing years to determine whether, like the Leonids and Andromedids of November, it develops unusual intensity near the time of return of the parent comet. W. F. DENNING.

SOME UNSOLVED PROBLEMS IN METAL-MINING.[1]

IN one sense every mine is an unsolved problem from the day the first pick is put into the ground until the mine is finally abandoned as exhausted, and even then it is not always certain that it really is worked out, and that sinking or driving another 10 feet might not give it a renewed lease of life. Unlike most engineering problems, which have generally to be solved before work is commenced, a mining problem is never fully solved until all work upon it is finally concluded.

At the very outset, even before we are in a position to attack the different subdivisions of the subject, we are brought face to face with what may almost be described as one of the fundamental problems underlying the whole of metal-mining, and one the solution of which can never attain finality. The work of the metal-miner being limited to the extraction from the earth's crust of the ores of the various metals, whilst it is the business of the metallurgist to smelt these, so as to reduce therefrom the metals that they contain, and to fit the latter for their use in the arts, the question what constitutes an ore is one that the miner cannot answer for himself, and for the reply to which he is dependent entirely upon the development of metallurgical science for the time being. Not all metalliferous minerals are ores from the smelter's point of view. Take, for example, an ordinary brick clay, which is a complex hydrous silicate containing, say, 15 per cent. of aluminium and 5 per cent. of iron; it is true that we can extract both these metals from it by a series of complicated laboratory processes, but no means for doing this economically on a practical working scale have yet been discovered. Hence no one would dream of calling clay an ore of aluminium, and far less of iron. Nevertheless, it is not beyond the bounds of possibility that our modern metallurgists, or their younger and more progressive brethren, the electro-metallurgists, may within a few years devise some practicable process for extracting aluminium from clay, when clay would straightway become an ore of aluminium, though it is not one now; and if perchance it happened that comparatively pure oxide of iron were obtained as a by-product in the same process, the clay might even be reckoned as an ore of iron also. Until some such process shall be devised, clay is looked upon by the metal-miner as a non-metallic mineral, as so much worthless gangue or waste. The history of metal-mining has shown again and again that the waste rock of one generation is the valuable ore of another, as, for example, the zinc blende of the Alston district, which is now being recovered from the waste which the old miners had left behind as worthless in their excavations, or had thrown aside on their waste heaps, the value of the mineral having been recognised when a Belgian metallurgist discovered how to extract zinc from it.

The point may be further illustrated by a consideration of the world's supply of iron ore; iron, the most useful of all metals, is at the same time, next to aluminium, the most abundant, geologists calculating that 4·7 per cent. of the earth's crust consists of iron; if this estimate be correct, the very small portion of the earth's crust underlying the London Metropolitan area (fifteen miles' radius) down to the depth of only one mile would contain no less than 360,000 millions of tons of iron, none of which is in the form of a true iron ore. At the present day no one would call a mineral containing less than 25 per cent. of iron an iron ore, and unless it contains double that percentage it will not find a very ready or a very appreciative market amongst iron smelters.

As the result of various improvements in the last few decades, the whole trend of modern mining is towards the utilisation of large deposits of low-grade material, the increased scale of operations enabling economies to be effected that were impossible whilst small quantities alone were dealt with. One of the cardinal problems that will confront our successors will be how to work with profit minerals of lower grade than any that we have yet attacked, so as to enable the miner to include within his sphere of operations deposits too poor for us to deal with to-day.

The possibility of determining by some means the whereabouts of the hidden treasures of the earth has long been an object of the miner's desire, the methods for accomplishing which range from the mediæval adept with his divining rod, belief in which is not wholly extinct to-day, down to a series of modern attempts to use electric currents for the same purpose. Up to the present these attempts have been unsuccessful, in spite of the ambitious claims of some of their advocates.

In view of the fact that minerals differ so widely in their electric and magnetic properties, it is quite possible

[1] From the "James Forrest" Lecture, delivered at the Institution of Civil Engineers on April 27 by Prof. Henry Louis.

to conceive that some method of detecting concealed mineral deposits by these means may be devised. Indeed, for one particular class of minerals such a method has long been in existence; in Scandinavia there are many deposits of magnetite, and many others of which magnetite forms a constituent, so that all such deposits distinctly affect a magnetic needle. The Swedish prospector has long used the so-called mining compass, which consists essentially of a small magnetic needle so suspended as to be able to move both horizontally and vertically. When this compass is brought over ground in which such deposits of magnetic mineral exist, the needle indicates their presence by its change of dip, so much so that it has been customary for years past in Sweden to buy and sell mineral properties by their "compass-drag," or their effect on the miners' compass.

When, by any means, some indication is obtained of the approximate position of a mineral deposit, it has to be more precisely located by boring. Boring is of but little value for tracing mineral veins, owing to their going down so nearly vertically and to their great irregularity, but it is often used to locate irregular masses of ore; for example, bore-holes have recently been employed successfully in Cumberland for proving deposits of red hæmatite in the Carboniferous limestone, even where this is overlain by Triassic rocks. Obviously bore-holes are most valuable when stratified deposits have to be tested, and everyone will remember the conspicuous success that attended their use in proving the permanence in depth of the auriferous banket beds of the Witwatersrand.

The deepest bore-hole put down up to the present is one at Paruschowitz, in Upper Silesia, which attained a depth of 6573 feet; it commenced at a diameter of 12·6 inches and finished at 2·7 inches, and it is easy to imagine the difficulties that attend the boring of so small a hole to the depth of 1¼ miles. The engineers in charge stated that they could not have reached this depth had not Mannesmann weldless steel tubes been available for the boring rods: I mention this fact as illustrating the dependence of mining upon the allied arts, for at first sight few would imagine that an improvement in special rolling-mill practice could increase our knowledge of the deeper portions of the earth's crust.

Bore-holes such as these are now always made by means of the well-known diamond drill, which brings up a core of the rocks passed through, and thus affords positive information respecting them. Unfortunately, the only kind of diamonds suitable for this purpose, the dark opaque stones, showing no distinct cleavage, known in the trade as "carbons," are very scarce and proportionately dear, so that diamond-drilling is now a very costly operation; I have, however, good grounds for saying that we are within measurable distance of seeing such "carbons," or at any rate "boot," produced artificially. For rocks of moderate hardness, these diamonds have of late years been replaced to some extent by shot made of specially hard chilled iron, but these are of little use in the harder rocks. One of our greatest needs at the present moment is a metal that shall be strong, tough, and very considerably harder than quartz; the production of such a material would conduce more to the technical advancement of several branches of mining than almost any other discovery that could be named.

Mineral deposits may be distinguished as superficial, shallow, or deep-seated in the earth's crust; the first of these require no opening up, properly speaking; the second can mostly be opened up by adit levels, whilst the third class can only be reached by means of shafts. The deepest shafts in the world are in the copper-mining district of Lake Superior, where there are at least two close upon 5000 feet in depth; with the exception of this district, of a few shafts in the Bendigo district of Victoria, a few at Johannesburg, and some in the Przibram mines in Bohemia, it may be said that there are practically no shafts in metal-mines more than 3000 feet deep, so that the ability to reach considerably greater depths than have hitherto been attained in most mineral fields may be taken for granted. Indeed, so far as the actual sinking is concerned, there would probably be no serious difficulty in sinking a shaft 10,000 feet deep, provided that it could be known with certainty that a deposit of ore would be met with of sufficient value to recoup the outlay incurred in such a sinking; in other words, the main problems connected with deep sinking are economic rather than technical.

For centuries the only property made use of to effect the separation of minerals was the difference in their densities; in 1858, however, an entirely new property was brought into play for the purpose, namely, the difference in their magnetic susceptibilities. This idea was due to a famous Italian engineer, Sella, whose name is well known in connection with the Mont Cenis tunnel. He was called upon to treat the iron ores of Traversella, in Piedmont, which consist of magnetite containing a certain proportion of copper pyrites (the mass carrying 2 per cent. to 4 per cent. of copper), which interfered with the use of the ore for iron smelting. Sella devised a machine carrying rotating electromagnets, by which the magnetic iron ore was separated from the non-magnetic copper ore, so that both could be utilised.

Other machines on similar principles were subsequently devised, and, naturally enough, they emanated from countries rich in deposits of magnetite, such as Scandinavia and some of the eastern States of America. Sweden especially took a prominent part in the development of the magnetic system of separation, and the Wenström machine, patented in 1884, which was one of the first practical machines brought out, is still largely used, as it is well adapted to the separation of lump ore. Other machines, more particularly designed for the treatment of finely crushed ore, were brought out in rapid succession, and to-day one of the main difficulties that beset the mining engineer lies in the selection of the most suitable machine for any given purpose out of the vast number with which the market is flooded. All these machines work either by means of a moving magnetic field, produced by travelling pole-pieces, passing through the mass of crushed ore, or by causing a stream of the ore to traverse a stationary field, these results being obtained either by travelling belts or revolving drums, or, as in the case of Edison's machine, by the deflection of a falling stream. It soon became apparent that, where very clean concentrates were required, the best results could only be obtained by applying magnetic separation to a pulp of mineral suspended in water, and wet magnetic separators were soon introduced, and are to-day preferred wherever possible; they avoid the necessity for artificial drying, which is, moreover, in the case of minerals that contain iron pyrites, apt to affect the magnetic susceptibility of this mineral sufficiently to interfere seriously with the success of the operation. Attempts have been made to devise magnetic separators without moving parts, by the use of polyphase rotating fields, but although the idea looks promising, no satisfactory machine on this principle has yet been constructed.

At first magnetic separation was only applied to the naturally magnetic ores, magnetite and magnetic pyrites; it was soon, however, extended to certain other minerals that can be rendered magnetic by heating, such as spathic iron ore, brown hæmatite, iron pyrites, &c. As early as 1875 a magnetic separator was used at Przibram for separating roasted spathic ore from zinc blende, this forming an excellent example of the value of magnetic separation. The presence of spathic iron ore causes great difficulties in smelting zinc ores, as it forms a readily fusible silicate of iron which destroys the zinc retorts; at the same time, the densities of the two minerals are so nearly the same that separation by ordinary dressing is impossible. The application of magnetic separation has solved the difficulty, and has rendered available for the smelter numerous ferriferous zinc ores that were previously useless. The process is receiving an extended application in America for treating argentiferous galena and zinc blende, finely divided, and intimately mixed with a large proportion of iron pyrites, in which the proportion of zinc is too high to admit of the ore being smelted direct, whilst the large amount of iron pyrites present interferes with ordinary wet dressing. This ore is crushed and then gently heated, which renders the pyrites magnetic, so that it can be removed by a magnetic separator; the dressing of the residual mixture of zinc and lead ores by the ordinary methods then offers no particular difficulties.

Whilst the ordinary methods of magnetic separation were thus extending the sphere of their applicability, another

form of magnetic separation was coming to the front. For a long time the method was confined to minerals that were naturally or artificially magnetic in the everyday acceptance of that word, that is to say, were capable of being attracted by an ordinary horse-shoe magnet. Faraday had discovered so far back as 1845 that numerous bodies, not magnetic in this ordinary sense, were nevertheless affected by powerful magnetic fields, but it was not until 1896 that this principle was applied to the separation of minerals by J. P. Wetherill; he succeeded in separating a series of minerals, all very feebly magnetic, from the somewhat more feebly magnetic zinc oxide and other zinc ores of New Jersey by the use of very powerful magnetic fields, produced by means of electromagnets with wedge-shaped pole-pieces, and since his original invention this principle (the magnetic separation of non-magnetic material, as it is sometimes called) has found an extended application, one of the most recent being the magnetic concentration of specular hæmatite by the Edison deflection method, using pole-pieces of the Wetherill type. Such separations as that of wolfram from tinstone, of raw spathic ore from zinc blende, of garnets from silver ore, which are necessary before any rational metallurgical treatment of the ores is possible, but which offer insuperable difficulties to the ordinary methods of dressing, have been rendered possible by the adoption of the Wetherill principle, and I see no reason to doubt but that it will find still more extended application in the future. I may point out that no successful wet separator for feebly magnetic minerals has yet been devised; this is a problem presenting numerous difficulties, but probably quite capable of solution, and at the same time very well worth solving.

Magnetic separation, though so comparatively novel, has already been extensively applied, the largest installations being naturally those for the treatment of iron ores. At the present moment the output of high-grade magnetite concentrate, produced by this process, in Sweden cannot fall far short of half a million tons per annum, and in Norway active preparations are in progress for work on a much larger scale at Dunderland, Salangen, Ofoten, and Sydvaranger, from which a yearly output of fully two millions of tons of high-class iron concentrates is expected.

Attempts to utilise other properties of minerals for their separation may be said to belong wholly to the present century. Thus Messrs. Blake and Morscher in 1901, and Mr. Negreanu in 1902, have attempted to use electrostatic methods, depending upon the variations in the electrification of minerals due to their varying electric conductivities; the former of these two methods has been used with success for the dressing of blende in the United States.

Finally, the difference in surface tension has been employed in Elmore's oil separation process, in the various flotation processes, devised since the discovery of the principle by C. V. Potter in 1901, and applied to the very intractable zinc-lead ores of the Broken Hill district of New South Wales, and finally in the Elmore vacuum process. All these processes seem to depend upon the differential adhesive force, with which water, oil, or gas cling to the surface of different minerals. These methods are still in their infancy, and the underlying principles cannot yet be said to be properly understood, but already they promise to be of great value in recovering valuable material from slimes that are not amenable to any other mode of treatment, particularly for treating those intimate mixtures of zinc blende and galena that have for so long defied the ingenuity of both miners and metallurgists. There are grounds for hoping that many of the problems that have hitherto baffled the ore-dresser may be solved by some application of these modern methods.

SCIENCE AND INDUSTRY.

A SERIES of articles has appeared in the *Revue scientifique* (May 18 and July 13, 1907; February 22, 1908) comparing the teaching of technical chemistry in France with the instruction given in the same subject in other countries. The last article is of special interest as presenting a French view of the relation subsisting between science and industry in our own country. After describing in detail the excellent organisation of scientific education in Germany, Belgium, and Switzerland, and emphasising the closeness of the union existing in these countries between the manufacturer and the man of science, it is stated that the system of technical education adopted in England presents no feature worthy of commendation.

The English manufacturer fails to realise how much he may profit from the assistance of pure science:—"l'industriel anglais paraît ou veut ignorer le chimiste de carrière qui vient à lui avec un bagage scientifique; son but étant de produire 'beaucoup et à bon marché' il lui suffit quand il remarque un ouvrier plus intelligent et plus perfectible que ses camarades de l'envoyer aux écoles du soir, prendre un semblant d'instruction théorique et cela sur la seule partie de la chimie qui peut intéresser son métier." The many technical colleges under the control of municipal authorities in this country do not aim at producing highly trained "chemists" in the scientific sense of the word, but waste their resources in providing evening classes for workmen and artisans, and in imparting the rudiments of science to boys from the primary schools.

The university colleges, on the other hand, with the exception of the Central Technical College, provide only a training in pure chemistry. Until science and industry become more intimately united in this country it is predicted that the technical schools will go on producing merely good workmen and the universities men who are unable to investigate practical problems or apply discoveries made in the laboratory on an industrial scale.

It would appear that the chemist is as little appreciated in France as in our own country, and it is pertinently asked whether this is not due to his lack of "*general* culture" which prevents him from acquiring the broad ideas necessary for the initiation or development of important enterprises. The same question no doubt may be asked of the chemists in this country, but whatever be the answer there is no doubt that, for the proper development of our industry in the near future, a closer union between the industrialist and the chemist is vitally necessary.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The board of managers of the Arnold Gerstenberg studentship gives notice that a studentship will be offered for competition in the Michaelmas term of 1909. The competition will be open to men and women who have obtained honours in part i. or part ii. of the natural sciences tripos, and whose first term of residence was not earlier than the Michaelmas term of 1903. The studentship, which will be of the annual value of nearly 90*l.*, will be tenable for two years.

The Linacre lecture will be delivered by Dr. W. Osler, F.R.S., on Wednesday, May 6, in the lecture-room of anatomy and physiology, New Museums. The subject of the lecture will be "Thomas Linacre, his Life and Works."

It is proposed to grant the use of the Senate House on May 15 for a meeting of the members of the University to be addressed by Mr. Haldane, Secretary of State for War, in the explanation of his scheme in connection with the training of officers for war.

Part i. of the natural sciences tripos will commence on Monday, May 25, and part ii. on Wednesday, May 27. The number of entries for the two parts is about two hundred and twenty.

GLASGOW.—Among the recipients of the honorary degree of Doctor of Laws on Commemoration Day, April 22, were several distinguished by their scientific attainments. In the afternoon a portrait of Prof. M'Kendrick was presented to the University, with the sum of 450*l.* for the equipment of a laboratory of experimental psychology in the new physiological buildings, in honour of Prof. M'Kendrick's thirty years' service to the University as professor of physiology. In presenting the representatives of science for the degrees, Prof. Gloag, dean of the faculty of law, made the following references to their work:—

MR. G. T. BEILBY, F.R.S., chairman of the governors of the Glasgow and West of Scotland Technical College.—The present head of the Glasgow and West of Scotland Technical College, who is a Fellow of the Royal Society,

has done much for the advancement of chemical science and of its applications to industry. He was president of the Society of Chemical Industry in 1899, and of the chemical section of the British Association at its meeting in South Africa in 1905. He was also vice-president of the Institute of Chemistry from 1903 to 1906. He is the inventor of novel processes which have created or transformed important departments of scientific production; he has devoted himself to the improvement of technological training in relation to our native industries, and he has contributed many researches of value to the memoirs of learned societies at home and abroad. The Senate, in presenting Mr. Beilby for the degree of Doctor of Laws, recognise the value alike of his scientific work and of his services to an educational institution so closely connected with the University and with the City of Glasgow.

COLONEL DAVID BRUCE, C.B., F.R.S., Royal Army Medical Corps.—A graduate of Edinburgh University, Colonel Bruce has had a distinguished career in the Royal Army Medical Corps, and rendered eminent services to the nation in the Egyptian and South African campaigns. But his services have been not only to his country, but to humanity. To his discovery, at great personal risk, and by untiring labour, of the microbe which forms the inducing cause of Malta fever, and to the researches to which that discovery led, the naval and military population of Malta owe their present immunity from a disease which has been the bane of the island for centuries. Similar work in Africa has resulted in extending our knowledge of the causes which produce the dreaded tsetse-fly disease of South Africa, and the epidemic sleeping sickness of Uganda. Work of this kind, requiring all the courage of the soldier, all the patience and acumen of the man of science, renders him amply entitled to any honour which a university can bestow.

DR. J. J. DOBBIE, F.R.S., director of the Royal Scottish Museum.—In Dr. Dobbie the Senate proposes to honour a distinguished son of this University. Dr. Dobbie completed a successful career as a student by graduating with first-class honours in natural science, and obtaining the George A. Clark scholarship. After further studies in Germany and in the University of Edinburgh, he obtained the degree of Doctor of Science in that University. He acted as lecturer in mineralogy, and as assistant to the professor of chemistry in Glasgow, until his appointment as professor of chemistry in the University College of North Wales at Bangor. After holding that office for nineteen years, he was appointed to the important post he now holds—the directorship of the Royal Scottish Museum. During a life thus filled with important educational work, he has found time to make contributions of great value to scientific literature, in recognition of which the Royal Society of London has admitted him to the honour of its fellowship.

MR. ROBERT KIDSTON, F.R.S.—Mr. Kidston has devoted much time and study to an important department of the science of geology, and is recognised as one of the leading authorities on palæophytology. A series of more than eighty papers, published under the auspices of the Royal Societies of London and Edinburgh, attest his knowledge of the Carboniferous flora. He has arranged and catalogued the collection of Palæozoic plants in the British Museum. His mastery of the subject, and his generous readiness to expend his labour for the advancement of science, have been taken advantage of by other countries than his own. He has been engaged in a catalogue of the fossil plants in the Royal Museum at Brussels, and has received an invitation to undertake similar work at Stockholm. The fossil remains, now being discovered in the recently opened coalfields of Holland, are being submitted for his determination. In presenting Mr. Kidston for this degree, the Senate of the University of his native city wish to express their appreciation of his manifold services to geological and botanical science.

DR. J. C. M'VAIL, medical officer of health for the counties of Stirling and Dumbarton.—A graduate of the University of St. Andrews, and a former examiner in medical jurisprudence and public health in this University, Dr. M'Vail holds the highest position in that important department of modern civil administration—the care of public health. For eighteen years county medical officer of health for Stirling and Dumbarton, he has been president of the Incorporated Society of Medical Officers of Health of Great Britain, of the Incorporated Sanitary Association of Great Britain, and of the Glasgow and West of Scotland Branch of the British Medical Association. In 1906 he delivered with acceptance the Lane lectures in Cooper Medical College, San Francisco, and the following year acted as medical investigator to the Royal Commission on the Poor Law. His published works, dealing with broad questions of State medicine and sanitary science, are recognised as authoritative in these important subjects.

THERE will be a reception at Bedford College for Women (University of London) on "Commemoration Day," Wednesday, May 6, after the presentation of graduates at the University of London.

AN article by Mr. J. A. Venn in the issue for the Lent term of the *Oxford and Cambridge Review* deals with the number of matriculations at Oxford and Cambridge, respectively, from 1544 to 1906. The article is accompanied by a graph, in which the number of matriculations—calculated on an average of five years about any given year from 1540 to 1907—and the years are plotted. The essay shows how the history of England has been reflected with clearness on university life, as evidenced by the varying numbers of students who came to pursue their studies at Oxford and Cambridge. The graph reveals two striking features:—first, both universities were in the first quarter of the seventeenth century as large as they were destined to be until 1850; secondly, the way in which the curves for the two universities keep repeating each other's movements at exactly the same dates, in most instances, and very frequently to exactly the same extent, showing that similar influences were affecting both universities throughout different centuries. Readers must be referred to Mr. Venn's article for detailed comparisons, but an example of the kind of interesting information which may be gleaned from the article may be given:—in 1630 one out of every 3600 of the male population of England and Wales proceeded to either Oxford or Cambridge, but in 1700 the figures were one in 5600. These figures continued to get steadily worse until 1801, when they read one in 11,400, but at the present day they stand at one in 9000.

THE Board of Education has issued (Cd. 4038) regulations for the preliminary education of elementary-school teachers in England, which will come into force from August 1 next. The new regulations contain various alterations, and among these, as being of special importance, may be mentioned that by which it will no longer be required that candidates for pupil teachership shall pass an examination test qualifying them for recognition by the Board as pupil teachers. A prefatory memorandum to the regulations points out that, since all pupil teachers must pass a leaving examination, which usually falls between the ages of seventeen and eighteen, it does not appear to the Board desirable, upon educational grounds, that they should also be called upon to pass an examination between the ages of fifteen and sixteen, except in so far as such examination may form part of the ordinary arrangements of the school at which they are being educated, or may be necessary in order to facilitate the proper selection of candidates. It is also satisfactory to find a recognition of the principle that the teacher should take a prominent part in any process of selection of suitable candidates. The Board hopes that, in view of the annually increasing proportion of candidates for pupil teachership who have received their preliminary education in secondary schools, it may be found possible, henceforward, for education authorities to base the selection and approval of candidates upon the advice of the teachers of the candidates rather than upon the results of an examination.

BY the will of the late Dr. H. C. Sorby, F.R.S., several substantial gifts are made for scientific purposes. The Sheffield Art Gallery and Museum will receive Dr. Sorby's large series of animals and marine alga, mounted as lantern-slides, and forming a continuous series illustrating the natural history of Kent, Essex, and Suffolk. Among

other bequests to the University of Sheffield are :—(*a*) Such of his books not bequeathed to the Literary and Philosophical Society as the University shall select; (*b*) optical and scientific instruments and apparatus; (*c*) cabinets and cases of geological and mineralogical specimens and preparations not bequeathed to the citizens of Sheffield; (*d*) manuscript books and notes upon geological and other scientific subjects; (*e*) lantern-slides similar to those bequeathed to the citizens of Sheffield, and the whole of his large collection of lantern-slides illustrating many scientific and other subjects; (*f*) microscopical objects of rocks, minerals and metals, and other things of a like nature. A legacy of 6500*l.* is bequeathed to the University, and the University is desired to appropriate out of other funds 3500*l.*, the amount of a gift which Dr. Sorby made to the University College of Sheffield in 1903, making together 10,000*l.*, as an endowment for a professorship of geology or such other subject as the University may think more suitable. This legacy is charged upon the funds to be appropriated to answer certain annuities given by the will and payable as and when the annuities fall in. To the Royal Society of London is bequeathed the sum of 15,000*l.*, the income therefrom to be devoted to the establishment of a fellowship or professorship for the carrying on of original scientific research. The object is to promote the discovery of new facts rather than the teaching of what is known. It is suggested that when possible the research shall be carried out in one of the laboratories of the University of Sheffield. This condition may, however, be dispensed with when the nature of the investigation requires that the work should be done elsewhere. So long as in the opinion of the council of the Royal Society the University of Sheffield is not efficiently equipped in laboratories and appliances, then the income shall be administered in such manner as the said council shall think best for the promotion of original research. Other legacies are :—the Literary and Philosophical Society of Sheffield, 500*l.*, and the Geological Society of London, 1000*l.*

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 27.—"The Influence of Temperature on Phagocytosis." By J. C. G. **Ledingham.** Communicated by Dr. C. J. Martin, F.R.S.

(1) When serum, cocci, and leucocytes are mixed directly and incubated at different temperatures, the number of cocci taken up increases more or less regularly with the temperature. By this method it has been shown that the phagocytic intake at 18° C. is only about one-fourth to one-fifth of that at 37° C.

(2) This fall, at least within the temperature range 37° C. to 18° C., is due to the diminished rate of combination of the serum with the coccus as the temperature falls.

(3) When cocci which have previously been exposed to the action of serum, either at 37° C. or at 18° C., are put in contact with leucocytes, the intake is practically the same, whether the phagocytosis takes place at 37° C. or at 18° C. The number taken up, however, after combination at 18° C., and more especially at 7° C., falls very short of the number taken up after combination at 37° C.

(4) Experimental results, detailed above, lead one to assume that prolonged contact of a serum with cocci at a low temperature (18° C. or 7° C.) leads to a maximum absorption of opsonin by the cocci (corresponding to that temperature), so that the subsequent phagocytosis is identical whether it takes place at 37° C. or at 18° C.

(5) Provided that cocci loaded with opsonin up to a certain maximum are presented to the leucocyte, the phagocytic energy of the latter is independent of the temperature within a wide range.

(6) From the appearances on stained films, it would seem that sensitised micro-organisms exposed to the action of leucocytes at very low temperatures tend to congregate near the periphery of the leucocytes, although little or no phagocytosis may take place. Hence, within a suitable temperature range, it may be presumed that the inclusion of sensitised micro-organisms by the leucocyte is a surface-tension effect taking place between the coccus and the protoplasmic wall, amœboid energy playing only a subordinate part in the process.

MANCHESTER.

Literary and Philosophical Society, March 24.—Prof. H. B. Dixon, F.R.S., president, in the chair.—An annotated list of the alien plants of the Warrington district: G. A. **Dunlop.** One hundred and seventy-five species, comprising with others several of Papaver, Senecio, and Sisymbrium, were enumerated in the paper. Thirty of these are now extinct.—Field notes on the birds of the Ravenglass gullery, 1906: C. **Oldham.** The author describes in his paper the habits, during the breeding season, of the black-headed gull, common, lesser, and Sandwich terns, as observed by him at Ravenglass, on the Cumberland coast. The term "gullery" he applies to that portion of the sandhills which is occupied by colonies of these birds. He also mentions other species—such as the oyster-catcher and sheld-duck—which nest in or in the immediate vicinity of the "gullery."

PARIS.

Academy of Sciences, April 21.—M. H. Becquerel in the chair.—An addition to the demonstration of the mechanism of monocular stereoscopy: A. **Chauveau.**—Concerning *Trypanosoma congolense*: A. **Laveran.** A goat, inoculated with *T. congolense* on November 15, 1906, was cured in July, 1907, from the infection produced by this trypanosome. Re-inoculated with the same organism on August 22, it was infected again, but the second infection was slight, and the animal was cured at the beginning of the following November. Two fresh inoculations, made December 20, 1907, and February 6, 1908, produced no re-infection; the goat had acquired immunity for *T. congolense*. Further inoculation of the same animal with *T. dimorphon*, made on April 1, 1908, produced a well-characterised infection, tending to prove that *T. congolense* constitutes a distinct species from *T. dimorphon*.—A new French observatory: Robert **Jonckheere.** This is the Hem Observatory, situated 8200 metres north-east of the fortifications of Lille. Astronomical observations will be commenced before the end of the year.—The influence of the silent discharge on the isolation resistance of insulators: F. **Nègre.** The resistance of the insulators studied was found to be constant up to a certain critical tension. The latter depends on the dimensions, form, and condition of the surface of the insulator, the resistance falling rapidly as soon as the silent discharge appears over the surface.—The flame spectra of iron: G. A. **Hemsalech** and C. **de Watteville.** The metal is obtained in a fine state of division by passing one of the gases supplying the burner over two electrodes of the metal, either an arc or sparks passing between the latter. The spectra obtained depended on the nature of the flame; thus with coal-gas and air in the region between λ 2250 and λ 5000 750 lines were obtained, with coal-gas and oxygen 250, and with hydrogen and oxygen 210.—The reducing power of the ferropyrophosphates: P. **Pascal.** Clear solutions of ferropyrophosphate of soda in water, together with a small amount of sodium pyrophosphate, reduce gold and silver, but not platinum salts. Salts of mercury and copper are also reduced, and there is a strong tendency to the production of highly coloured stable colloidal solutions of the metals.—Combustion without flame, and its application to lighting with incandescent mantles: Jean **Meunier.** The author holds that the temperature of the mantle is much higher than that of the flame surrounding it, and attributes this to the fact that each particle of oxide becomes the focus of an intense local combustion. The combustion by incandescence lowers considerably the inferior limit of inflammability of a gas mixture.—A demonstration of Gibb's phase rule: J. A. **Muller.**—Remarks on a wire-drawing machine of the seventeenth century: Ch. **Fremont.**—The progress of modern surgery judged by the statistics of operations on the knee (resections): M. **Lucas-Championnière.** For this particular operation the mortality has been lowered from 36 per cent. or higher to less than 1 per cent. by the

application of the antiseptic methods of Lister. These results were obtained without the use of an aseptic operating room.—The structure of the trachean network of the excretory canals of the kidneys of *Machilis maritima*: L. **Bruntz.**—The Senonian and the Eocene of the north edge of the Moroccan Atlas: A. **Brives.**—A fan-shaped apparatus of Cetorhinus found in the fossil state in the Antwerp Pliocene: Maurice **Leriche.**—The direct measurement of the vertical component of terrestrial magnetism. Application to the exploration of the chain of Puys: B. **Brunhes** and P. **David.**

DIARY OF SOCIETIES.

THURSDAY, APRIL 30.

ROYAL SOCIETY, at 4.30.—On Scandium: Sir William Crookes, F.R.S.—Note on the Representation of the Earth's Surface by Means of Spherical Harmonics of the First Three Degrees: Prof. A. E. H. Love, F.R.S.—On the Hysteresis Loss and other Properties of Iron Alloys under very small Magnetic Forces: Prof. E. Wilson, V. H. Winson, and G. F. O'Dell.—The Relation between the Crystalline Form and the Chemical Constitution of the Picryl Derivatives: G. Jerusalem and Prof. W. J. Pope, F.R.S.—The Condensation of Certain Organic Vapours: T. H. Laby.—A Photographic Determination of the Elements of the Orbits of Jupiter's Satellites: B. Cookson.

ROYAL INSTITUTION, at 3.—Mendelian Heredity: William Bateson, F.R.S.

ROYAL SOCIETY OF ARTS, at 4.30.—Reminiscences of Indian Life: Lord Lamington, G.C.M.G., G.C.I.E.

MATHEMATICAL SOCIETY, at 5.30.—On a General Convergence Theorem, and the Theory of the Representation of a Function by Series of Normal Functions: Dr. E. W. Hobson.—On the Multiplication of Series: G. H. Hardy.—On q-Integration and Differential Equations: F. H. Jackson.—On the Upper and Lower Functions of a Sequence of Continuous Functions: Dr. W. H. Young.—(1) On Mersenne's Numbers; (2) On Quartans with numerous Quartan Factors: Lt.-Col. A. Cunningham.—The Relation between the Convergence of Series and Integrals: T. J. I'A. Bromwich.—Porisms: H. Bateman.—The Influence of Viscosity on Wave Motion: W. J. Harrison.—On the Ordering of the Terms of Polars and Transvectants: L. Isserlis.

FRIDAY, MAY 1.

ROYAL INSTITUTION, at 9.—The Scientific Work of Lord Kelvin: Prof. Joseph Larmor, Sec.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—Structural Analogies between Alloys and Igneous Rocks: W. G. Fearnsides.

SATURDAY, MAY 2.

ROYAL INSTITUTION, at 3.—Chile and the Chilians: G. F. Scott Elliot.

MONDAY, MAY 4.

ARISTOTELIAN SOCIETY, at 8.—The Methodological Postulates of Psychology: Dr. T. Percy Nunn.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Manufacture of Sodium Nitrite: Dr. G. T. Morgan.—On some Simple and Mixed Esters of Cellulose. The Alkaline Decomposition of Nitro Derivatives of Cellulose and other Carbohydrates: Dr. W. Smith, junr.—The Mechanism of Filtration: E. Hatschek.—Metanil Yellow; its Use as a Selective Indicator: E. Linder.—The Conversion of Oleic Acid into Stearic Acid: Dr. J. Lewkowitsch.

INSTITUTE OF ACTUARIES, at 5.—The Select and Ultimate Method of Valuation: M. M. Dawson.

TUESDAY, MAY 5.

ROYAL INSTITUTION, at 3.—The Development of the Modern Turbine and its Application: Gerald Stoney.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Report on the Hythe Crania: F. G. Parsons.

WEDNESDAY, MAY 6.

ROYAL SOCIETY OF ARTS, at 8.—The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds: Lovell N. Reddie.

GEOLOGICAL SOCIETY, at 8.—Solution-Valleys in the Glyme Area (Oxfordshire): Rev. E. C. Spicer.—On the Stratigraphy and Structure of the Tarnthal Mass (Tyrol): Dr. A. P. Young; with a Note on Two Cephalopods, collected by Dr. A. P. Young on the Tarnthal Köpje (Tyrol): G. C. Crick.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Examination of Oil of Turpentine and Turpentine Substitutes: J. H. Coste.—The Estimation of Ferrocyanide in Crude Commercial Products: Dr. H. G. Colman.—Studies in Steam Distillation. Part iii., The Fatty Acids: H. Droop Richmond.—A New Method for Milk Testing, and some Remarks on the Sydney Supply: W. M. Doherty.

THURSDAY, MAY 7.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Helium and Radioactivity in Rare and Common Minerals: Hon. R. J. Strutt, F.R.S.—The Action of Resin and Allied Bodies on a Photographic Plate in the Dark: Dr. W. J. Russell, F.R.S.—A Tantalum Wave-detector, and its Application in Wireless Telegraphy: L. H. Walter.—Seleno-aluminium Bridges: Prof. G. M. Minchin, F.R.S.

ROYAL INSTITUTION, at 3.—Mendelian Heredity: William Bateson, F.R.S.

CHEMICAL SOCIETY, at 8.30.—The Interaction of Diazonium Salts with Mono- and Di-hydric Phenols and with Naphthols: K. J. P. Orton and R. W. Everatt.—The Condensation of Benzoin with Methyl Alcohol: J. C. Irvine and D. McNicoll.—The Mutual Solubility of α-Methylpiperidin and Water: O. Flaschner and B. MacEwen.—The Melting Points of the Anilides, p-Toluidides, and α-Naphthylamides of the Normal Fatty Acids: P. W. Robertson.—The Refraction and Dispersion of Triazo-compounds: J. C. Philip.—The Dissociation Constants of Triazoacetic and α-Triazopropionic Acids: J. C. Philip.—The Absorption Spectrum of Camphor: W. N. Hartley.—The Viscosity of Solutions: C. E. Fawsitt.—The Action of Fused Potassium Hydroxide and of Hydrogen Peroxide on Cholesterol, Preliminary Note: R. H. Pickard and J. Yates.—The Fermentation of Mannose and Fructose by Yeast Juice, Preliminary Communication: A. Harden and W. J. Young.—The Volumetric Estimation of Silver: W. R. Lang and J. O. Woodhouse.—The Constituents of Olive Leaves: F. B. Power and F. Tutin.—The Constituents of Olive Bark: F. B. Power and F. Tutin.

LINNEAN SOCIETY, at 8.—Colony-formation as a Factor in Organic Evolution: H. M. Bernard.—Antipatharia from the Voyage of H.M.S. *Sealark*: C. Forster-Cooper.—A List of the Fresh-water Fishes, Batrachians, and Reptiles obtained by Mr. J. Stanley Gardiner's Expedition to the Indian Ocean: G. A. Boulenger, F.R.S.—A Cinematographic Representation of the Movements of Peripatus and other Invertebrate Animals: F. Martin Duncan.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Abbreviated Formulæ for Structural Engineers: E. Fiander Etchells.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Manufacture of Electrical Condensers: G. F. Mansbridge.

FRIDAY, MAY 8.

ROYAL INSTITUTION, at 9.—Ice and Its Natural History: J. Y. Buchanan, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY, at 8.—A Modified Theory of Gravitation: Dr. C. V. Burton.—An Examination of the Formulæ for the Grading of Cables: C. S. Whitehead.—Illustrations of Geometrical Optics: R. M. Archer.

SATURDAY, MAY 9.

ROYAL INSTITUTION, at 3.—Chile and the Chilians: G. F. Scott Elliot.

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