THURSDAY, JULY 25, 1907.

## DILLENIAN MEMORIALS AT OXFORD.

*The Dillenian Herbaria: an Account of the Dillenian Collections in the Herbarium of the University of Oxford, together with a Biographical Sketch of Dillenius, Selections from his Correspondence, Notes, &c.* By G. Claridge Druce. Edited, with an introduction, by Prof. S. H. Vines, F.R.S. Pp. cxii+258. (Oxford: The Clarendon Press, 1907.) Price 12*s.* 6*d.* net.

THIS volume is a valuable contribution to the history of the botanic preeminence of Oxford in the first half of the eighteenth century. It is significant that the three men Carl Linnæus visited in 1736 were Sir Hans Sloane, Philip Miller, and Dillenius. His credentials to the first were a commendatory letter from Boerhaave; but Sloane was then seventy-six, he had seen the rise and fall of many botanic arrangements, was a follower of our own John Ray, whose system he had adopted when indexing his large collections of plants, and was averse to further change. To him the young Swede of twenty-nine, with a brand new scheme of his own, was a visionary to be dismissed with speed, and therefore, with a few cold compliments, Linnæus departed. With Philip Miller, the gardener to the Company of Apothecaries at Chelsea, he became acquainted, bringing with him letters from his patron Clifford, and a mutual appreciation was the result. The residence of Dillenius at Oxford was the chief attraction which drew Linnæus to that place; there he stayed a month, and might have shared the liberal offer of Dillenius to divide the emoluments of the professorship between them had he so wished.

At this time Dillenius had been only two years installed as Sherardian professor, though he had received the stipend from the death of William Sherard. His tenure of the chair from 1734 to his death in 1747 was a bright interlude between two uneventful periods.

Mr. Druce has drawn up this account of the collections left by Dillenius, and has critically examined the specimens preserved as vouchers, illuminating many doubtful passages in the third edition of Ray's "Synopsis," and practically disposing of the dubious entries which have troubled many subsequent botanists. For studies of this character the facilities offered at the Botanic Garden, Oxford, are extremely good, and only to be excelled by the Sloane volumes in the department of botany, Cromwell Road. Mr. Druce has performed a labour of love in bestowing the work of years on these collections, and should be encouraged to persevere until all the more important of the pre-Linnean herbaria at Oxford are enumerated in similar detail. It should not be forgotten that the types of Sibthorp's splendid "Flora Græca" are also preserved at Oxford.

The introduction by Prof. Vines is an appreciative essay on the position of Dillenius as regards his contemporaries; then, with a single page of preface, Mr. Druce gives a life of Dillenius and bibliography, a full selection from his extant correspondence (the letters from Linnæus have, unhappily, disappeared), and thus, after an ample preamble, the principal portion of this volume begins.

Part v. opens with the collation of the Dillenian edition of Ray's "Synopsis" issued in 1724, with the plants preserved in that special herbarium. This edition was practically the chief guide of British botanists for something like forty years, in fact until Hudson's "Flora Anglica" superseded the Raian method by the Linnean system and nomenclature. We have for the first time an authoritative statement of what is in the herbarium, and what stands there for any given name.

Next and in similar fashion we find an account of the specimens representing the plates and descriptions in the "Hortus Elthamensis," that account of the garden of James Sherard the plates of which were etched by Dillenius. Following this we come to the great work of the author, the "Historia Muscorum," with a prefixed statement of the authorities whose determinations are the basis of the modern reductions; errata and index close this interesting volume.

The temptation to dwell longer on this theme is strong, but must be resisted; the book vividly recalls days spent long ago amongst these very plants and manuscripts, and this notice must end with the hope that another instalment from this treasure house may in due time be forthcoming. B. D. J.

## THE FOURTH INTERNATIONAL ORNITHOLOGICAL CONGRESS.

*Proceedings of the Fourth International Ornithological Congress, London, June,* 1905, *forming Vol. xiv. of the "Ornis."* Edited, under the direction of the President, Dr. R. Bowdler Sharpe, by the Secretaries, Dr. Ernst J. O. Hartert and J. Lewis Bonhote. Pp. 696; with 18 plates. (London: Dulau and Co., 1907.) Price 21*s.* net.

AS in many other branches of science, the ornithologists have established an international congress, and the official account of their fourth meeting, held in London in June, 1905, is now before us. It forms a handsome and well-illustrated volume of 696 pages, and constitutes also the fourteenth volume of *Ornis*, the official journal of the association, which accompanies the presidency of the congress when it is moved from one country to another.

The first meeting of the International Congress of Ornithologists was held at Vienna in April, 1884, under the presidency of Dr. Gustav Radde, of Tiflis, and owes its inception, more or less, to the ill-starred Crown-Prince Rudolph of Austria, who had a certain amount of interest in natural history, inspired chiefly, we believe, by one of the Brehms, his personal friend and companion. The meeting at Vienna was a success to a certain extent, and was followed seven years later by the second meeting, which took place at Budapest in 1891. This congress was very well attended, and was carried out with great *éclat* by the enthusiastic naturalists of the Hungarian capital. English ornithology was represented by the

late Mr. Danford and by Dr. Bowdler Sharpe, who read there an important paper on the classification of birds. The presidents on this occasion were Prof. Victor Fatio, of Geneva, and Dr. Otto Herman, of Budapest. The next meeting of the congress was deferred for several years from various causes. But the difficulties were at length surmounted, and the ornithologists of every part of the world were invited to assemble at Paris in June, 1900, under the presidency of the late Dr. Oustalet, the head of the magnificent collection of birds in the Jardin des Plantes. Although ornithologists are not numerous in France, the meeting in Paris was very well attended, and included visitors from all parts of the world. Many excellent communications were made to it. At the close of the *séances* it was resolved that the next (fourth) meeting of the congress should take place in England in 1905, and Dr. R. Bowdler Sharpe, the well-known head of the Bird Department at the Natural History Museum, South Kensington, was selected as its president. The present volume gives us a full account of the proceedings of this meeting, which was held in London in June, 1905, and was attended not only by the English devotees of ornithology, but by representatives of that science from France, Germany, Austria, Hungary, Italy, Holland, Belgium, Russia, Sweden, Switzerland, the United States, Canada, and Australia.

The fourth congress was opened at the Imperial Institute, South Kensington, on June 12 by a few words from the outgoing president, Dr. Oustalet, who then vacated the chair in favour of Dr. Sharpe, the new president. Dr. Sharpe gave a most interesting and instructive address on the origin and progress, from 1753 to the present time, of the national bird-collection in the British Museum, which is now by far the finest and most nearly complete of its kind in the world. This address, which is printed in full in the present volume, gives particulars of the additions made to the great collection year by year since its foundation, together with details on its mode of arrangement and government. By bequest, purchase, and presentation, Dr. Sharpe tells us, nearly every large private collection of birds made in England has ultimately passed into the British Museum, including those of the late Marquess of Tweeddale, Mr. Seebohm, Mr. Crowley, Mr. Allan Hume, Dr. Sclater, Mr. Osbert Salvin, Dr. Godman, and other well-known naturalists.

After the president's address the present volume is mainly occupied with the papers read at the meetings of the congress and at its various sections. These sections were five in number—systematic ornithology and distribution; migration; biology and nidification; economic ornithology; and aviculture. Excellent communications, altogether forty in number, were made on all these subjects. They are mostly of a somewhat technical character, but we may direct attention to Mr. Walter Rothschild's paper on extinct and vanishing birds, which was splendidly illustrated by the large series of specimens and drawings shown to the ornithologists when they made their excursion to Tring. We may also invite notice to Mr. Pycraft, who writes on the origin of the differences between the various kinds of nestlings, and seeks to justify his ingenious theory that all birds "were originally arboreal."

Those who require information on the eleven Acts for the Protection of Wild Birds passed by our Parliament may refer to Sir Digby Pigott's paper on this difficult subject read before the economic section, while those who keep birds in aviaries should not fail to study Mr. D. Seth-Smith's address on the importance of aviculture as an aid to the study of ornithology. The numerous and interesting facts ascertained by the votaries of this new branch of science are well set out in Mr. Seth Smith's contribution to the present volume.

## THERMODYNAMICS.

*Thermodynamics: an Introductory Treatise dealing mainly with First Principles and their Direct Applications.* By Prof. G. H. Bryan, F.R.S. Pp. xiv+204. (Leipzig: B. G. Teubner; London: D. Nutt; Williams and Norgate, 1907.)

PROF. BRYAN has not been content in this work to follow closely the beaten track, but has given us the results of much original research. The fundamental conceptions of energy, available or unavailable, of entropy, and of temperature are given in their simplest form (see the general summary at end of the book).

As the conception of temperature is for the most part new, and throws much light on the subject, it is well to set out the author's definition. The absolute temperature of a body M is to be understood, and can be defined, only with reference to another standard body N. It is the ratio between the quantities of heat respectively taken from M and imparted to N, when M is used as reservoir, N as refrigerator in a reversible Carnot cycle. This, of course, is, and is intended to be, a theoretical definition only; and a theoretical definition is needed. Similarly, the entropy of a body cannot be defined as an absolute quantity. We can only say that in certain circumstances it increases or diminishes. In all irreversible transformations it increases by an amount equal to the available energy transformed into unavailable energy. Two definitions of entropy are given at p. 58.

Prof. Bryan encounters the usual difficulty in defining temperature, density, &c., *at a point* in a molecular medium. Given a continuous medium, we say that (for instance) the density at P is the limiting ratio of quantity to the containing volume when that volume (which contains P) becomes infinitely small. That definition is irreproachable, but, as applied to a medium consisting of discreet molecules, wholly devoid of meaning. It is possible to give a logical definition by proceeding to the limit in the other direction. But in practice—and Bryan follows the practice—it is usual to define density as the number of molecules in an element of volume at P—large compared with molecular dimensions, it being assumed for the purpose of the definition that the density may

be taken without sensible error as constant throughout small distances near P. The same method applies *mutatis mutandis* to temperature.

The chapter on the diffusion of gases from the point of view of thermodynamics requires more explanation than the author has directly given. He says (p. 125):—

"When two gases at equal temperature and pressure mix by diffusion, the gain of entropy is the same as would occur if each were to expand by escaping into vacuum till it occupied the volume of the mixture."

To this Advocatus Diaboli would say, If instead of two gases you have two quantities of the same gas, oxygen, *caeteris paribus*, the whole system remains throughout in the same physical state, and, therefore (art. 86 [2]), there is no gain of entropy. What difference can it make that one volume of oxygen is replaced by nitrogen?

I think Prof. Bryan would justify his statements thus:—He asserts, art. 124 (*a*), "as two gases at equal pressure and temperature in general tend to mix by diffusion and not to separate, the process of diffusion is irreversible." And he implies (*b*) that every irreversible process necessarily involves increase of entropy. If these principles (*a*) and (*b*) be granted, 125 is probably justified. But they are both very questionable.

It is not possible within the limits of this notice adequately to discuss either (*a*) or (*b*). I would, however, point out that in diffusion, as in all motions of gases, if at any instant the velocities of all the molecules were reversed the system, if isolated, would retrace its course. Does not this fact make a broad distinction between diffusion of gases and irreversible processes usually admitted as such?

S. H. BURBURY.

## VOLCANOES.

*I Vulcani Attivi della Terra. Morfologia—Dinamismo —Prodotti Distribuzione Geografica-Cause.* By G. Mercalli. Pp. viii+421; illustrated. (Milano: Ulrico Hoepli, 1907.) Price 10 Lire.

THIS history of the study of volcanoes may be divided into three periods; the earliest is covered by the fragmentary remains of the writings of classical philosophers and the sporadic records of great eruptions of Vesuvius and Etna during the Middle Ages; the second commenced with the eruption of Vesuvius in 1631, which gave rise to over 200 publications, and from this date on we have a fairly complete record of the activity of Vesuvius and Etna; in the third period, observation became systematised, and vulcanology, as a science, may be said to date from Spallanzani's study of Stromboli in 1788. In the nineteenth century the science expanded its boundaries, volcanoes in other parts of the world besides Italy began to be studied, experimental methods were applied to elucidating the mechanism of eruptions and the formation of volcanic rocks, and the microscope to the investigation of their composition and structure.

As a consequence of this expansion of the science it has come to pass that we have had to look, not to Italy, but to other countries, and especially to England, for a general handbook; Prof. Mercalli has rectified this, and the country where the study of volcanoes, and the science of vulcanology, took their birth has produced the best and most complete guide to their pursuit. In the compass of a moderate sized book, we have a remarkably complete, well-balanced review of the subject, which commences with the final result of volcanic activity, in an account of the rocks produced, and works back through the forms of volcanoes, their dynamics, and distribution, to the cause of volcanic activity.

The longest and most generally interesting chapter in the book is doubtless that dealing with the dynamics of volcanoes. Fissure eruptions and the outflow of lava without the formation of a volcanic cone are recognised, and in the classification of volcanic explosions we come across a third type—in addition to the familiar vulcanian and strombolian types—in what are termed plinian eruptions. This name is applied to the violent explosive eruptions, like that of Vesuvius in 79 A.D., of Bandaisan and of Krakatoa, which follow prolonged periods of repose, are of extraordinary violence, are accompanied by comparatively little or no outpouring of lava, while causing the ejection of large volumes of previously solidified material, and are succeeded by another period of repose. The eruptions of Pelée and St. Vincent in 1902 are regarded as differing in degree only, not in kind, from other known eruptions; the celebrated spine of Pelée, which was thrust up to 1000 feet above the crater, was an extreme case of extrusion of solidified lava, and the "black cloud" an extreme case of the avalanches of incandescent ashes which are a not uncommon accompaniment of great eruptions.

In dealing with the cause of volcanic activity, Prof. Mercalli favours the view, first propounded by Seneca, that it is produced by the access of sea water to highly-heated material in the interior of the earth, resulting in the production of high-pressure steam; but here, as elsewhere throughout the book, the theory is not pressed, and alternative explanations are fairly stated. A word, too, may be said for the illustrations, which are numerous and excellent.

## OUR BOOK SHELF.

*Shaft Sinking in Difficult Cases.* By J. Riemer; translated from the German by J. W. Brough. Pp. xii+122; with 18 illustrations and 19 folding plates. (London: Charles Griffin and Co., Ltd., 1907.) Price 10s. 6d. net.

MR. RIEMER is one of the leading German authorities on sinking, and a translation of his valuable treatise forms an addition to English technical literature that is specially welcome in view of the fact that shaft sinking, the most complicated of all mining problems, is necessarily dealt with in a brief manner in the standard works on coal-mining. The volume is confined to a description of means that have to be resorted to when ordinary methods of sinking cannot be applied on account of excessive influx of water, the means described being shaft sinking by hand, boring shafts, the freezing method of sinking, and the sinking-drum method.

The particulars given relate exclusively to recent

practice in Germany, where, unfortunately for the colliery owners, the subject of shaft sinking in circumstances of special difficulty has necessarily received special attention. Some of the difficulties recorded are appalling. For example, the sinking of a shaft at the Rheinpreussen colliery occupied twenty years, and at the Friedrichshall shaft sinking thirty-four yards cost no less than 437*l.* a yard with the shaft-boring process, whilst the unsuccessful attempt to sink ten yards by pumping cost 1563*l.* per yard. The author favours the Kind Chaudron method of sinking by the process of boring, a method that has never been known to fail. The freezing process, which was devised in 1883, has been applied in sixty-four cases, the deepest being at the Schieferkaute mine, where the ground had to be frozen to a depth of 240 yards. The depths that can be dealt with by this process are limited by the plasticity of ice.

The value of the author's detailed descriptions is greatly enhanced by the large-scale dimensioned drawings of the various shafts. On the whole, the volume furnishes those in charge of mining undertakings with a review of the various methods that may be used in difficult cases of sinking, so that the selection of the best method for any particular case is facilitated. It is not a book for elementary students, but one that deserves the careful study of advanced students and of experienced engineers. The translation has been carefully made, and a bibliography and index, that are wanting in the German edition, are undoubtedly valuable additions.

*Die philosophischen Grundlagen der Wissenschaften.* by Prof. B. Weinstein. Pp. xiv+543. (Leipzig and Berlin: B. G. Teubner, 1906.) Price 9 marks.

THIS volume contains a series of thirty-five lectures originally delivered in the University of Berlin. A wide range of subjects is treated—from sense-perception to time, space, causality, substance, hypothesis, explanation. As the lecture form is preserved, the discussion never becomes crabbed or too compressed—a great virtue in a book—and the author moves naturally and easily whithersoever the topic leads him. He touches no subject without elucidating it, and the hope expressed in the preface that the work will be of some value alike to specialists and ordinary readers will, we are sure, be amply fulfilled. In particular the work may be heartily recommended to young philosophical students with some knowledge of German who are trying to crack some of the nuts of psychology and metaphysics. Had Prof. Weinstein but added at the end of each chapter a short list of other discussions of his subject that might profitably be consulted, our gratitude would have been even greater than it is.

A few indications of the author's standpoint and mode of treatment must be given. The attempt to "explain" phenomena of consciousness by physical terms like attraction, pressure, vibration of molecules, and the like is well characterised on p. 54, where it is pointed out what utter folly it would be thought to "explain" in the same way the inertia of lifeless substances as caused by vibrations of the substance. How competing perceptions are unified is a topic that occupies several excellent pages. We see things upright, although the retinal image really shows the object in an inverted form. Prof. Weinstein is at pains to contest the view that this takes place because the judgment of the sense of touch is so powerful as to overwhelm that of the sense of sight. He points out, for example, that all orientation in space takes place with reference to our bodies, and we judge according to the movements which we perform with parts of our bodies. "Below" means what we have to bend our bodies to touch; "above" what we must stand on tip-toe to touch. If we saw everything inverted, according to the information supplied by the retinal image, we should see our bodies as well in an inverted position. Hence the sense of touch, and the sense would always give harmonious judgments. The treatment of the *a priori* nature of Zeitlichkeit and of the whole subject of causality leaves little to be desired, and atomism and æther have a few illuminating paragraphs. It is an excellent volume in every way.

*The Toxins and Venoms and their Antibodies.* By Em. Pozzi-Escot. Authorised translation by Dr. Alfred T. Cohn. Pp. vii+101. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 4*s.* 6*d.* net.

WE regret that we are unable to speak favourably of this little book. In 100 short pages an attempt is made to survey the whole domain of toxins, bacterial, vegetable, and animal, of the venoms and of antitoxins, with the result that it is superficial and sketchy. It teems with errors in spelling, and with curious sentences, probably due to faulty translation, *e.g.* Micocher for Miescher, Rauson for Ransom, tumors for humors, Chauvée for Chauveau, Zalnosky for Zalensky, methylotoxin for mytilotoxin, &c.; mussels are spoken of as crustacea, and scorpions as insects; it is stated that "toxins act as toxic agents only when in a condition to be introduced into the circulation sub-cutaneously," "the action of bee poison is very often benign," "*in vitro* it (antivenine) acts quite as well preventively as therapeutically," and so on. R. T. HEWLETT.

*Everyman's Book of the Greenhouse (Unheated).* By W. Irving. Pp. 247. (London: Hodder and Stoughton, n.d.) Price 5*s.* net.

THE designation "unheated" is a convenient term to denote a greenhouse in which there is no set heating apparatus. A small stove that will keep out the frost adds materially to the utility of a greenhouse, as it is thus possible to provide a winter domicile for half-hardy plants, besides enabling the possessor to force plants into growth and prepare plants for window boxes or house decoration.

The author has extended the limits of his selection to include alpine plants and others that are especially suitable to pot culture. The directions as to choice and management are based on Mr. Irving's long experience at Kew, and are simply and clearly expressed. The longer paragraphs, such as that on the genus Primula, are the most instructive, and since it is easier to grow a few kinds well, these might have been amplified to the exclusion of certain of the less important genera. The numerous photographs are very effective and fascinating, but the coloured plates are not attractive.

*"Mephistopheles." The Autobiography and Adventures of a Tabby Cat.* By Keiro (Charles Yates Stephenson); with illustrations by Louis Wain. Pp. 158. (London: Jarrold and Sons, n.d.) Price 2*s.* 6*d.*

AN interesting account is given of the episodes in the life of a cat possessed by Mr. Stephenson for more than eighteen years. The narrative and the excellent illustrations will both appeal to young people.

*Healthy Boyhood.* By Arthur Trewby; with an introduction by Sir Dyce Duckworth, and a Foreword by Earl Roberts. Pp. viii+63. (From the author.) Price 1*s.* 6*d.*

THIS booklet contains useful advice to boys, expressed is a temperate manner; it may be commended to the attention of parents and schoolmasters.

## 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 Origin of Radium.

IN replying to Mr. Soddy's communication published in NATURE of June 13 (p. 150) I cannot refrain from expressing my regret on learning that he has apparently taken my paper in the *American Journal of Science* for December, 1906, as such a serious "criticism" and "imputation" on my part in dealing with his paper on "The Production of Radium from Uranium." It was my intention merely to point out certain conditions of experiment which appeared to me to be quite essential to the solving of the problem of the growth of radium in uranium compounds, conditions which had apparently been neglected in his own experiments, and to show that where these conditions had been fulfilled the results were not in agreement with those which had been obtained by him. I was then, and am still, of the opinion that the experimental procedure which Mr. Soddy adopted was not suited to give conclusive results of either a positive or negative character, and this opinion is certainly strengthened by the fact that, under very similar conditions of experiment, Prof. Rutherford was unable (Bakerian Lecture, Phil. Trans., 204, 218) to observe the growth of radium in a solution of Giesel's "emanating substance," although he has since concluded that radium was actually being produced in quite notable quantities.

My suggestion of the "accidental and unconscious introduction" of radium salts during Mr. Soddy's tests was only one of a number of possible sources of error to which I have already directed attention. That the other suggestions have not met with his disapproval, and that he is at least convinced of the necessity of starting with purified uranium salts, would seem probable from his statement that he is now continuing the investigation with purified uranium compounds. I am very glad to learn that the results which he has now obtained entirely confirm and extend the results which I have already published. It may be of interest to add that my original solution of one hundred grams of *purified* uranium nitrate has recently been tested and found, after a period of more than two and one-half years, to contain less than $10^{-11}$ gram of radium.

"The experiments described in this paper are considered to indicate that the results obtained by Mr. Soddy are without significance and that one or more products of a slow rate of change intervene between uranium and radium." This is the particular paragraph to which Mr. Soddy now raises an objection. I fully realise that this statement is open to criticism; it was an unsuccessful effort at brevity. A longer but more satisfactory summary would perhaps have been:—The results of the experiments described in this paper are in support of the hypothesis that one or more products having a slow rate of change intervene between uranium and radium, and indicate that the results obtained by Mr. Soddy are without quantitative significance in so far as they relate to the production of radium by uranium.

"Commercial salts" of uranium may contain, and usually do contain, quite appreciable amounts of every constituent of the minerals from which they have been prepared. The presence in such salts of a small proportion of the immediate parent substance from which radium is derived is therefore in itself no indication of any genetic connection whatever between uranium and radium. My observation of the growth of radium in actinium preparations, even if it has served no other useful purpose, has certainly indicated where the immediate parent of radium is to be sought. To judge from the results which I have obtained in recent experiments along the same lines it would appear that, unless the rate of disintegration of radium now assumed is greatly in error, the chemical process outlined in my "Note on the Production of Radium from Actinium" is capable of effecting the essentially quantitative separation of the radium parent from most of the other substances present in a uranium mineral.

In conclusion, it may be desirable to direct attention to the fact that the only evidence we now have that radium is a disintegration product of uranium is the constancy of the ratio between the quantities of these two elements in the natural minerals, a relation which was first pointed out in these columns by the writer. BERTRAM B. BOLTWOOD.

Yale University, New Haven, Conn., June 29.

### The "Double Drift" Theory of Star Motions.

I HAVE been greatly interested in Mr. Eddington's account in NATURE of July 11 (p. 248) of Prof. J. C. Kapteyn's investigations of this subject. Although I do not quite follow his argument for the existence of two overlapping systems of stars (more dramatically termed "two Universes" by Prof. Turner), I yet venture to suggest an explanation of the apparently (perhaps really) opposite "drifts," which seems to me to agree sufficiently with the observed facts.

If we adopt Lord Kelvin's postulate of a single vast stellar universe very slowly condensing towards its common centre of gravity, we might expect that the component stars would move for the most part in ellipses or spirals of very varying degrees of eccentricity and of inclination to the mean orbit—perhaps indicated by the Milky Way. If we further postulate (what is very generally admitted) that our sun is situated towards the central rather than towards the outer portion of the whole system, then, just as the planets, through differential angular motions as regards the earth, appear sometimes to move in a retrograde direction or to be quite stationary, so a certain proportion of the stars might be expected, at any given period, to exhibit the same phenomena.

But further, considering the enormous distances that are known to separate the stars and star-groups from each other and the extreme slowness of their angular motions, there seems no reason why their respective orbits should not be almost as frequently in a right-hand as in a left-hand direction in regard to the central plane of general motion.

Our knowledge of the actual motions of the stars may not inaptly be compared to what astronomers would possess of the solar system supposing the whole of their observations had been limited to a period of about twenty-four hours, and that the sun was invisible. The motions of the planets and their satellites thus determined would seem as strange and incomprehensible as do those of the stars at the present time, our accurate observations of which have been limited to a few centuries.

It will probably be of interest to many of your readers (as it certainly will be to myself) if some of your mathematical correspondents will explain why, and in what way, some such system as is here suggested is incompatible with the facts set forth by Prof. Kapteyn and others.

ALFRED R. WALLACE.

IN the article to which Dr. A. R. Wallace refers, and elsewhere, I have confined myself to attempting to establish the result that the stars distribute themselves into two systems according to their motions, abstaining as far as possible from defining what physical connection is implied by the rather vague word "system." Whether the two systems are comparatively permanent and have come together from different parts of space, or whether they may have been evolved from a single system, is, in the present state of our knowledge, a somewhat speculative question, and it is with some reluctance that I enter upon it. Still, without asserting that the hypothesis of two *permanent* systems is the only possible one, I know at present of no other satisfactory explanation. In the system suggested by Dr. Wallace (in which the stars move about the centre of the universe in ellipses, some forward and some retrograde, with all sorts of eccentricities) the motions would be for our purposes haphazard. Thus the system would form a single and not a double drift; the extremely eccentric orbits form a perfect transition between the direct and retrograde orbits. To account for two drifts, it is not sufficient to show that some stars move forward and some backward; it must be shown that there is a concentration of the motions about two definite veloci-

ties (definite in magnitude and direction), and it does not appear to me that the suggested system provides for this. In fact, it is difficult to see how gravitation towards the centre of the universe could separate the motions of the stars into two systems, if they originally formed one system. A. S. EDDINGTON.

Royal Observatory, Greenwich, July 18.

### The Dental Formula of Orycteropus.

NORMALLY the adult Orycteropus has in each jaw but five teeth, though frequently, especially in young animals, a number of smaller teeth are found further forward. In 1890, Mr. Thomas discovered in both the upper and lower jaws of fairly large fœtal specimens a number of milk-teeth, seven in the upper and four in the lower jaw. So far as I am aware, nothing further has been discovered regarding the dental succession.

In the skull of a newly-born specimen which I have been enabled to study through the kindness of Dr. Perinquey, of the S. African Museum, I have been fortunate in finding a full set of milk-teeth in both upper and lower jaws. In the upper are three minute but calcified incisors, one canine and six premolars. Of these only the last five premolars probably cut the gum, and only the fourth and sixth are large enough to be functional to a slight extent. Succeeding teeth are found under the third, fourth, fifth and sixth premolars, and possibly under the second. Beyond the sixth premolar there is evidence of at least four true molars. In the lower jaw there are also three minute calcified incisors, one minute canine, and six milk-premolars. Of these the second, third, fourth, fifth, and sixth premolars probably cut the gum, and are slightly functional. The germs of replacing teeth are found in connection with all the premolars except the first. Behind the last premolar are evidences of five true molars. The dental formula of Orycteropus may thus be taken to be :—

| Incisors | Canine | Premolars | Molars |
|---|---|---|---|
| | | ? 3 4 5 6 | 1 2 3 4 5 |
| *1 2 3* | *1* | *1 2 3 4 5 6* | |
| *1 2 3* | *1* | *1 2 3 4 5 6* | |
| | | 2 3 4 5 6 | 1 2 3 4 5 |

This dental formula is quite unlike that in any living mammal, but if we assume that the ancestor of Orycteropus had functional succeeding incisors, and canines, it would have had a formula not at all unlike that found in many of the Mesozoic mammals. Elliot Smith suggests that it may have branched off very early from the subungulate stem. Kitchen Parker was more impressed with the resemblances of the skull to that of the marsupials and lower insectivores.

Some further light may be obtained by a careful microscopic examination of the developing teeth, which I hope to undertake immediately. R. BROOM.

Victoria College, Stellenbosch, June 25.

## *THE RADIO-TELEGRAPHIC CONVENTION.*

THE report of the select committee appointed to consider the radio-telegraphic convention drawn up by the Powers in November last has just been published as a parliamentary paper. The committee recommends, by a majority of five to four, the ratification of the convention, a result which will hardly surprise those who have followed the evidence given before the committee, though the narrowness of the majority may be difficult to understand.

The provisions of the convention have already been summarised in NATURE (vol. lxxv., p. 59, November 15, 1906), so that it will not be necessary to repeat them here. It will be recollected that it was then pointed out that the provision of prime importance, and the only one likely to lead to opposition to the ratification of the convention, was the one requiring that "coast stations and ship stations are bound to exchange radio-telegrams reciprocally without regard to the particular system of radio-telegraphy adopted by these stations." The necessity for this provision and the highly beneficial results likely to accrue from its enforcement to civilisation and maritime interests were described, and the hope was expressed that the private interests of the Marconi Company would not stand in the way of its adoption.

A study of the evidence presented to the committee and clearly summarised in its report shows that the only opposition to ratification came from those representing the interests of the Marconi Company. They, having already secured what amounts to a practical monopoly so far as Great Britain, Italy, and Canada are concerned, are not unnaturally desirous of maintaining and increasing that monopoly. Whether the policy of not ratifying the convention which they support is likely to lead to such a result seems more than doubtful. The evidence shows that, so far as the world as a whole is concerned, the Marconi Company do not possess even a majority of existing stations, but only about one-third of the total number.

The ratification of the convention by all the signatory Powers except Great Britain would inevitably lead to a growth of other systems at the expense of Marconi stations: existing Marconi stations under their control would necessarily be discontinued unless they consented to acquiesce in the provision for intercommunication. The numerous stations existing along the south coast of England, if they refused to intercommunicate, would be useless for the shipping of foreign nations using other systems, and the necessity for the erection of other stations in their place on the north coast of the Continent would arise. If these, as is probable, interfered with the working of the English stations, protest would be useless from a country outside the convention. From almost all points of view it seems, as a matter of fact, that the Marconi Company stands to gain rather than to lose by the adoption of the convention by Great Britain.

Of the technical objections raised by the Marconi Company little need be said. Since the representatives of all the other systems were agreed that there exist no real difficulties in intercommunication from the technical standpoint, one is compelled to the conclusion that these objections are biassed by other considerations, unless, indeed, the Marconi system is so inferior to all others that it alone possesses this great disadvantage.

It will be recollected, probably, that great stress was laid by many writers in the daily Press at the time of the international Conference on the naval and military aspects of the convention, and Great Britain was represented by some as handing herself over bound to the Powers. That these contentions were entirely without foundation was pointed out in NATURE (*loc. cit.*), and would have been clear to anyone who took the pains to study the actual provisions of the convention. The section of the report of the select committee dealing with this aspect of the question should be sufficient to dispel any lingering doubts which may still remain.

Wireless telegraphy has been very much before the public for the past ten years. In sensational achievement much has been accomplished, and of recent years it has figured somewhat largely as an international bone of contention. But the practical commercial development has been disappointingly slow. It is to be hoped that with the ratification of the convention a period of peaceful progress may ensue, and that some of the well-deserved fruits of many years of patient experimenting may be gathered by the numerous inventors who have been working in this field. MAURICE SOLOMON.

## THE LIFE OF ST. PATRICK SCIENTIFICALLY TREATED.[1]

PATRICIUS MAGONUS SUCATUS, the Roman-Briton from South Wales who became the apostle and patron saint of Ireland, was a great man, who occupies a large place in history, and Prof. Bury has presented us with a great biography, worthy of the subject and of the brilliant equipment brought to bear on it.

Our "fabulous" lives of saints are full of facts, often strangely disguised and misplaced. The venerable records deserve the most thorough scientific treatment, of which this book is a noble illustration. Our remarks by way of review will be confined to some points of interest to astronomers and archæologists.

We were curious to learn when and how St. Patrick's Day, March 17, became a fixed festival. It is with Patrick, as with many another saint, that while the circumstances of his death are very obscure, the day stands forth with a positiveness which at once challenges inquiry. The saint died in 461 A.D. He was "buried quietly in an unmarked grave." "The pious excitement about his bones arose long after his death." In searching this book for information about the day, a very curious state of things discloses itself. The author says that the legendary date of the saint's death "had become vulgar in the seventh century," but the earliest reference we can find is the statement of a scribe who died in 846 A.D., a postscript to a copy of Patrick's "Confession." "Huc usque uolumen quod Patricius manu conscripsit sua: septem decima Martii die translatus est Patricius ad cælos" (p. 227). That was written 385 years after the saint's death. Though we should have liked to have the matter more clearly explained, we make it no point to doubt that March 17 was observed before the ninth century. What strikes us is the fact that in 846 A.D. that was the date of the vernal equinox. It is hard to believe that the Irish of the ninth century could have celebrated St. Patrick's Day without noticing the coincidence.

Turning to the legend of the saint's death, we find him converted into a solar hero. An angel predicted that his death would "set a boundary against night that no light might be wasted on him: Up to the end of the year there was light, that was a long day of peace" (p. 264). Another version has it that "after his death there was no night for twelve days, and the folk said that for a whole year the nights were less dark than usually." The one version seems to refer to the equinox, and the other to the summer solstice when for twelve days before and twelve days after the sun's declination is within its highest northward degree.

It is of interest to note that our two native British patron saints, Patrick and Dewi, seem to have been made solar heroes. In the legend of the death of Dewi, or David, we have a midsummer festival described in Christian terms, and there is ample evidence that Dewi's day was June 24 before it was fixed on March 1.

When Patrick became a solar hero, assuming that he did, he became entitled to the shamrock. About the only thing one finds it hard to forgive in our author is that he never mentions the shamrock. How can we think of Patrick and March 17 without the shamrock? We must have it brought in. The story of how Patrick utilised the popular triadic herb to teach the Irish the fundamental dogma of his faith bears the stamp of truth as clearly as anything known of him. He found the plant in great popularity among the "pagan" Irish, as well as among his Brythonic countrymen. The Welsh bards used to decorate their spring Gorsedd with the trefoil, and, as we shall see, Patrick had a great deal to do with the Gorsedd. To Celts, who thought in threes, the plant had possibly no rival as an emblem.

We have now associated an equinox and solstice date, a solar hero, and a Gorsedd emblem which our modern bards state was used at the equinox. But our modern bards have evidently changed the order of festivals, substituting the solstitial quarter days for those of the May-year. The shamrock must have belonged originally to the May-day festival, as February would be too early for it. Patrick found in Ireland the May-year in its glory, and he set about changing it into the Church-year, as part of his mission. Legend represents him lighting a fire on Easter Eve in open defiance of the fire lit on the selfsame night at Tara in connection with a high pagan festival. Our author rightly interprets the legend..

"The idea is that Easter is to replace Beltane, the Church to overcome the heathen fire, and it is a matter of no importance that the day of Beltane was the first day of summer, which could never fall on Easter Eve" (p. 107).

"We can detect here, in the very act as it were, the process by which pagan superstitions which insisted on surviving were sometimes adapted into the Christian calendar" (p. 108).

The legend of the saint's death has quite a Beltane setting. "A thorn-bush burst into flame on the wayside and was not consumed. And an angel spoke and turned him back" to Saul, to die there rather than at Armagh. A thorn-bush bursting into flame, *i.e.* flowers, before March 17 reminds us of the Glastonbury thorn-bush flowering at Christmas. There is also a legend of an Irish saint presenting a queen with a dish of blackberries at the Easter festival. Over and over again the early Church festivals are spoken of in Beltane and All Hallows terms. The chief reason seems to be that for a long time the early British and Irish Christians had no effective substitutes for the May-year festivals.

Descriptions of British pagan and early Christian festivals should be read with the aid of whatever light the bardic Gorsedd, which was once common to all parts of the British Isles, can lend us. Where Patrick lay dead, angels who kept watch over his body diffused "sweet odours of wine and honey," which is dangerously like representing the angels holding a typical Irish wake. The angels are the bards who, dressed in white, presided over the ceremonies of the Beltane feast, and wine and honey were their customary dues on such an occasion, liberal quantities of which consumed at the feast diffused sweet odours. The legend strives to harmonise the pagan feast, the Church festival, and the anniversary of Patrick's death.

This brings us to a very instructive episode in the saint's life, his attack on the "King Idol of Erin." In the plain of Slecht was a famous idol, "apparently of stone covered with silver and gold, standing in a sacred circuit, surrounded by twelve pillar stones." "It was told in later times that the firstlings, even of human offspring, used to be offered to this idol, in order to secure a plenteous yield of corn and milk, and that the high kings of Ireland themselves used to come at the beginning of winter to do worship in the plain of Slecht." Our author thinks that "the story is based on a genuine fact, but that the later accounts impute to it a significance which it did not possess." The story relates that Patrick struck down the idol with his staff, which, Prof. Bury observes, he could not have done without the consent of secular powers.

[1] "The Life of St. Patrick, and his Place in History." By Prof. J. B Bury. Pp. x+404. (London: Macmillan and Co., Ltd., 1905.) Price 12s. net.

It is the clear truth of the setting of the story that strikes us most. What Patrick attacked was a pagan Gorsedd, and the incident is of great value as showing the use of the stone circle in the fifth century. We seem to see it in use in the earliest of Welsh tales, but we cannot assign definite periods to the incidents recorded. Here, however, we have a fairly historical episode, which should be read with Geoffrey of Monmouth's account of the May festival at Stonehenge, also in the fifth century. The Slecht Gorsedd was the same in plan as the present Welsh one—a large stone surrounded by twelve other stones. The disappearance of the former goes far to prove the truth of the history. In Wales the Gorsedd was not suppressed in the interests of Christianity. It actually received Christian baptism. The first Gorsedd after the introduction of Christianity among the Welsh is called in the bardic records "Cadair Fedydd," baptismal chair. It is an expression that explains how in

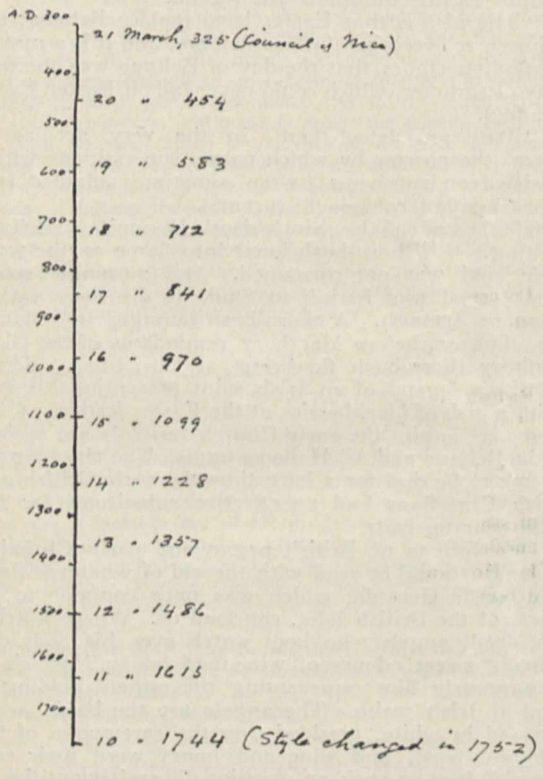


FIG. 1.—Diagram showing changes of the equinox-solstice date.

Wales it is unreasonable to look for any gap in the history of the Gorsedd there.

Our author has narrowed the inquiry into the birthplace of Patrick to the Severn estuary. Had he used some Welsh traditions about Patrick in Glamorgan he might have settled the question for good. There is a persistent tradition that Patrick was kidnapped by "pike-bearing" Irishmen from Llantwit-Major, in that county, and Mr. T. C. Evans (Cadrawd) has found three Banwens in that neighbourhood, either of which would suit for the Bannaventa mentioned as Patrick's home.

The accompanying diagram (Fig. 1) embodies the method by means of which Sir Norman Lockyer was able to note the equinoctial significance of St. Patrick's Day, before the facts mentioned by the present writer were available. Such a diagram may prove very useful to the historian. The changes in date have been calculated as from the Council of Nice, and each change represents an error of a day in 129 years. By a similar calculation as from B.C. 46, the beginning of the Julian Year, the 17th was an equinox date from A.D. 728 to 859, covering the whole period during which the particulars about Patrick were put together for an ecclesiastical purpose.

The present writer has found the following working hypothesis very useful in determining the significance of anomalous or irregular fair days. Any dates between the 10th and the 20th in March, June, September, and December may be suspected to be arrested solar days. When other evidence confirms such a supposition, the period of the institution of the fair or festival may be found by means of the above diagram. The process of arrest referred to is very evident in the case of fairs. In 1824 there were two three-days' fairs held at Bradford. One was on December 9, 10, and 11, being the dates of the fair before the change of style. The other fair was on June 17, 18, and 19. If the last figure is to be regarded as the solstice, we are taken back to 600 A.D. But it would be safer to regard the 17th as being the first of the three solstitial days, and that in the ninth century. The 17th is an important fair day, and it happens that St. Alban's Day is given in English calendars as June 17. The Welsh bards have somehow introduced the name Alban as that of a solstitial quarter day. That would naturally be suggested if Alban's Day at any time fell on the solstice, which may very well have happened in the ninth century. In an old Welsh calendar of about 1471 A.D., Alban's Day is June 22, when the date of the solstice was the 13th. That, however, does not dispose of our theory. By regarding the 22nd as the middle solstice day preceding the Council of Nice, we get the very period of the British proto-martyr. It was when the 21st was a solstice date that the earliest Christian calendar in the West was compiled, and it is possible that Alban's Day was fixed from the very first on the 22nd. The 21st is still called St. Alban's Eve. The question, therefore, is, Have we in the case of Alban's Day two arrested solar dates?

JOHN GRIFFITH.

## NOTES.

SIR HENRY ROSCOE, F.R.S., and Sir William Ramsay, K.C.B., F.R.S., have been nominated foreign members of the Accademia dei Lincei, Rome.

THE Vienna Academy of Sciences has awarded the Baumgarten prize to Prof. E. Ritter v. Schweidler, for his work on the phenomena of dielectrics; the Lieben prize to Prof. H. Benndorf, for his work on the transmission of earthquake waves in the interior of the earth; and the Haitinger prize to Dr. Robert Kremann, for his work on the esters.

WE learn with regret of the death of Prof. Egon von Oppolzer at the early age of thirty-seven. Dr. von Oppolzer, who was a son of the celebrated Theodor von Oppolzer, was born at Vienna in 1869, and was educated at the universities of Vienna and Munich. In 1897 he became an assistant in the observatory at Prague, where he discovered in 1901 the variability in the brightness of the planet Eros. In the latter year he was appointed extraordinary professor of astronomy at Innsbruck, where he remained until his death. Among the subjects on which he wrote are astronomical refraction, solar physics, and the application of physical theory to stellar problems. He also made contributions to meteorology. A new form of zenith telescope was constructed by him, as well as a photometer of novel design. The

variability of the minor planets, which has recently become a subject of very great interest, has naturally been investigated with the greatest success by the aid of photography, and it is worthy of note that Dr. von Oppolzer's important discovery in this branch of research was established by visual observations.

A MEETING of the Institution of Mechanical Engineers will be held on July 30–31, in the Mitchell Hall of the University, Aberdeen. The following papers will be read:—Aberdeen Harbour, by Mr. R. G. Nicol; cableways used on shipbuilding berths, by Mr. J. M. Henderson; portable pneumatic tools, by Mr. H. Bing; granite quarrying in Aberdeenshire, by Mr. W. Simpson; an electrically-controlled single-lever testing-machine, by Mr. C. E. Larard; observations on present-day practice in jute preparing and spinning, by Mr. D. J. MacDonald.

AFTER the current year the *Journal of Anatomy and Physiology* will be issued in two independent parts, one to be devoted to anatomical, histological, morphological, and embryological subjects, and the other to contain papers on subjects of physiological interest (including physiological histology and physiological chemistry). The acting editor of the anatomical part will be Prof. D. J. Cunningham, with whom will be associated Sir William Turner, K.C.B., Prof. A. Macalister, and Prof. G. S. Huntington. The acting editor of the physiological part will be Prof. E. A. Schäfer, with whom will be associated Profs. F. Gotch, W. D. Halliburton, C. S. Sherrington, and E. H. Starling.

THE Red-Hills Exploration Committee has issued an interim report for 1906. The committee is a joint committee of the Essex Archæological Society and the Essex Field Club appointed to make a systematic study of the red-hills, of which there are probably several hundreds on the coast of Essex alone. Work was commenced in the parish of Langenhoe, and three mounds have been examined thoroughly, particulars concerning which are given in the interim report. The red-hills vary in size from a few rods to several acres; they date from a remote period, and some at least are prehistoric. By some they have been regarded as salt works; by others as cattle shelters, human habitations, potteries, or glass factories. The object of the committee is to decide the question of their origin and significance, and an appeal is made for funds. Donations may be sent to Mr. H. Wilmer, St. Alban's Crescent, Woodford Green, Essex.

THE seventy-fifth annual meeting of the British Medical Association will be held at Exeter from July 27 to August 2. The president, Dr. R. A. Reeve, will deliver his address on July 30. The address in medicine, on "A Plea for Accuracy of Thought in Medicine," will be delivered on July 31 by Dr. W. H. White; that in surgery, on "The Contagion of Cancer in Human Beings, Autoinoculation," on August 1 by Dr. H. T. Butlin; and the popular lecture, on "Weather, Climate and Health," on August 2 by Sir John W. Moore. There will be thirteen sections, and the names of these, with that of the president in each case, are as follows:—Pathology, Dr. R. Moore; medicine, Dr. W. Gordon; diseases of children, Mr. A. H. Tubby; psychological medicine, Dr. T. C. Shaw; electrical section, Dr. H. L. Jones; tropical diseases, Mr. J. Cantlie; surgery, Prof. G. A. Wright; ophthalmology, Mr. L. H. Tosswill; larynology, otology, and rhinology, Dr. R. McKenzie Johnston; dental surgery, Mr. J. McKuo Ackland; obstetrics and gynæcology, Mr. E. H. Tweedy; State medicine, Dr. A. Newsholme; and naval and military, Dr. J. Porter.

ON Friday last, July 19, the new laboratory buildings erected by the Royal Horticultural Society in their gardens at Wisley, Surrey, were declared open by Lord Avebury in the presence of a large and distinguished assembly interested in the development of horticulture and in horticultural education in this country. The company was entertained to luncheon in the gardens by the council of the society, and the speakers after lunch included, in addition to Lord Avebury, Sir Trevor Lawrence, K.C.V.O. (president of the society), Lord Balfour of Burleigh, Sir William Chance, Sir Thomas Elliott, K.C.B., Prof. Michael Sadler, Sir William Vincent, and Sir John T. Dillwyn-Llewelyn. The laboratory buildings, which are the first in this country erected for the specific purpose of prosecuting research in horticultural science, include a research laboratory, a greenhouse for experimental work, a photographic dark-room, an office and store-room, and a students' laboratory accommodating twenty-four students at a time. The latter is equipped with all the necessary appliances for the study of plant life and its relationships to external conditions, and is excellently lighted and furnished with water and acetylene gas supply to the benches, &c. The subjects upon which the first researches are to be carried out are soil sterilisation and the etherisation of plants. The director of the laboratory is Mr. F. J. Chittenden, who was until recently a staff instructor in biology at the technical laboratories at Chelmsford.

THE following additional papers have been promised for reading before Section A of the British Association at the Leicester meeting:—On the motions of ether produced by collision of atoms or molecules, containing or not containing electrons, Lord Kelvin; on variability in the products resulting from changes in radium emanation, Sir W. Ramsay, K.C.B.; on the production and origin of radium, Prof. E. Rutherford; the effect of high temperature on the activity of the products of radium, Prof. E. Rutherford and Dr. J. E. Petavel; Helium and radio-activity in common ores and minerals, Hon. R. J. Strutt; the transmission of the active deposit from radium emanation to anode, S. Russ; the absorption of gases by charcoal, Miss I. Homfray; on a theoretical method of attempting to detect relative motion between the ether and the earth, A. O. Rankine; the ultimate efficiency of illuminants, C. V. Drysdale; the variability in light of Mira Ceti and the temperature of sun-spots, Rev. A. L. Cortie; (1) on improving the plate constants of the astrographic catalogue, (2) on the determination of periodicity from a broken series of maxima, Prof. H. H. Turner; (1) some new results in the theory of functions of a real variable, (2) on the introduction of the mathematical idea of infinity, W. H. Young; the teaching of the elements of analysis, C. O. Tuckey.

IN the *Strand Magazine* for June, Mr. J. J. Ward, with the aid of numerous excellent photographs, tells the life-history of the goat-moth in a remarkably graphic manner.

IN the report of the Rugby School Natural History Society for the past year, attention is directed to the gift by Miss Loveday of a large collection of shells. Although these have been safely stored, the society lacks a conchologist capable of arranging the specimens in proper order.

THE second number of *British Birds* contains, as frontispiece, a striking portrait of the late Prof. Alfred Newton, reproduced from a photograph by Mayall. The publishers, Messrs. Witherby and Co., have also issued this photogravure in a large size suitable for framing. Mr. P. H

Bahr continues his account of the life of the osprey; while Messrs. Witherby and Ticehurst discuss additions made to the British bird-list since 1899.

REPORTS of papers and discussions on museum-fittings and the difficulties experienced by curators owing to reflection from the glass in exhibition galleries occupy a considerable space in No. 12 of the *Museums Journal* for the current year. Reflection is considered to present an insurmountable difficulty, which might, however, have been mitigated in many museums had more attention been paid to the needs of the exhibits when the buildings were designed. The same issue contains reprints of two addresses sent by the Trustees of the British Museum (natural history) to Upsala on the occasion of the recent celebrations in honour of Linnæus.

WE are indebted to the author, Mr. Henri Piéron, of the physiological laboratories at Sorbonne, for copies of several papers from the *Comptes rendus de la Société de Biologie* dealing with experiments to determine the nature of the factors which induce sleep. In the first of these the nature of the experiments to be instituted on dogs for this purpose is discussed, while in the later ones such results as have at present been obtained are noticed. From the same author we have also received a paper from the Bulletins of the Institut général psychologique dealing with the "psychophysiology" of the sea-anemone *Actinia equina*.

CONCHOLOGISTS will be interested in two papers by Mr. Burnett Smith in the May issue of the Proceedings of the Philadelphia Academy. In the first the author discusses the genus Pyrula, which has existed since the late Eocene, and is now distributed in nearly all shallow tropical seas, a distribution suggesting that these seas had much freer intercommunication than is at present the case. Some of the Tertiary gastropods formerly included in Volutilithes, but now separated by the author as Athleta, form the subject of the second paper, in which the early stages of growth of these shells are discussed in detail.

A PROSPEROUS year in all branches is recorded in the report of the Yorkshire Naturalists' Union for 1906. An important piece of work undertaken by the geological section is the zoning of the Carboniferous rocks, which was inaugurated at the Ingleton meeting. The collection of photographs of important local rock-sections also continues to receive special attention. It is satisfactory to learn that the pair of peregrine falcons has continued to breed on Bempton Cliffs, although this is somewhat discounted by the driving away of a second pair which attempted to nest at Ingleboro'. Fortunately, in both instances public opinion is strongly in favour of protective legislation.

AT the close of an article in the *American Naturalist* for June on the perception of colour by the eye, Mr. J. M. Dane summarises the three chief theories which have been proposed to explain the phenomenon. According to the first of these, all colours may be received by each cone of the retina; the second claims that not more than two colours can be impressed on any one cone; while the third admits the reaction of only one colour on a single cone, so that there are separate blue, red, yellow, and other cones, and corresponding transmission-fibres in the optic nerve. According to this third hypothesis the mixing of sensations, which gives rise to shades and tints, must take place in the brain. Evidence in favour of the same view is afforded by the fact that no nerve is known to respond to impulses of distinct kinds; but it should be borne in mind that no corroborative evidence is at present afforded by anatomy. Attention may also be directed to a paper in the same issue by Mr. A. B. Wright on a graphic method of correlating the environment and distribution of fishes.

DESPITE a falling-off in the number of papers read, the South London Entomological and Natural History Society, of which the report for 1906–7 is now before us, has to record a successful year's work. One of the features of the year was an exhibition of natural history objects held in the society's rooms in March last, which attracted a large number of visitors. The report is illustrated by several interesting photographs, from among which we are enabled, by the courtesy of the editor, to reproduce one illustrating a marvellous protective resemblance of a moth to its surroundings. So closely, indeed, do the colouring and contour accord with the bark upon which the insect is resting that it requires somewhat minute examination to detect the presence of the latter. A second, although somewhat less striking, case of the resemblance of a moth to its surroundings is shown in another photograph, where a specimen of *Aplecta nebulosa* is depicted on oak-bark at Leith Hill.

A specimen of the moth *Xylina ornithopus* reposing on oak-bark in the New Forest. From Report of S. London Entomological and Nat. Hist. Society, 1906–7.

THE second edition of the volume of the official guide to the museums of economic botany at Kew, devoted to dicotyledons and gymnosperms, has been out of print for some years, and is now replaced by a third edition, that has been carefully revised and considerably augmented, from which the gymnosperms have been excluded. Besides furnishing a guide to the collections at Kew, the book provides a valuable authority on the popular and scientific names of economic products and their sources.

THE floras of the small islands known as sand keys, lying to the westward of Key West off the coast of Florida,

also of the Marquesas and Tortugas groups, are graphically shown in a series of maps prepared by Mr. C. F. Millspaugh as publication No. 118 of the Field Columbian Museum. The mangrove vegetation in which *Rhizophora mangle* is the dominant species is an almost universal feature; an association of *Uniola paniculata* and *Euphorbia buxifolia* is commonly found, and a characteristic growth of *Suriana maritima* occurs on two of the Tortugas keys.

A SYSTEMATIC attempt is now being made to catalogue the flora of the county of Glamorgan. The work was done partly by the late Mr. John Storrie, but the new catalogue is being compiled by Prof. Trow, of the University College, Cardiff, assisted by a number of competent members of the Cardiff Naturalists' Society, and with the advice and help of Mr. A. Bennett, of Croydon. The catalogue will appear in the Transactions of the Cardiff Naturalists' Society, and is not expected to reach the complete form for another four years.

IN the botanical section of the Philippine Journal of Science, vol. ii., No. 1, contains a collation of Philippine Cyperaceæ founded on the material in the Kew Herbarium by the late Mr. C. B. Clarke, and a short list of Philippine myxogastres named by Mr. G. Massee. In connection with an account of the pteridophytes collected by Mr. E. D. Merrill on Mt. Halcon, in Mindoro, Prof. E. B. Copeland, who is responsible for the identifications, notes the predominance of the Celebes element over the Bornean. The collection includes a large number of species of Polypodium, several of which are new, four new species of Diplazium, *Tmesipteris tannensis*, and a new species of Lycopodium.

THE first number of vol. ii. of the botanical memoirs of the Department of Agriculture in India relates to diseases of cereals caused by *Sclerospora graminicola*, a member of the Peronosporeæ. While dealing with a matter of economic importance, the author, Dr. E. J. Butler, also gives consideration to the teratological aspect. The most interesting alteration occurs in the central prolification of the floral axis with the suppression of the pistil. The mycelium attains its maximum development in the leaves, and the reproductive organs are only produced there. The conidia arising on short, stout stalks germinate in water and give rise to zoospores; oogonia are formed in the leaf tissues at a later stage. Sclerospora disease has also been observed in India on *Sorghum vulgare* and Italian millet.

IN a reference to the sixth report of the Woburn Experimental Fruit Farm (NATURE, July 4, p. 231), Mr. F. V. Theobald stated that it had been found that "lead arsenate wash badly scorches the leaves under certain conditions and at certain strengths." Mr. Spencer Pickering informs us that the results obtained at the Woburn Fruit Farm do not lead to this conclusion; and upon referring the point to Mr. Theobald we find that the word "badly" written by him in his article should have been "slightly."

IN the *Philippine Journal of Science* for May there are an address delivered by Dr. Paul Freer, on modern theories of immunity; a preliminary communication, by M. Mirjajima, on the cultivation of a bovine piroplasma, in which it is shown that the *Piroplasma parvum* of cattle in a blood-broth culture medium seems to develop into trypanosomes; and an exhaustive article, by Messrs. Ashburn and Craig, on dengue fever.

WE have received a copy of the special bulletin of the State Board of Health containing a summary of the sanitary legislation in the United States enacted during 1906. Among others, we note that Massachusetts and Rhode Island have passed Acts to prohibit the misuse of vessels used in the sale of milk; Mississippi has passed an Act requiring the disinfection of public buildings, railway depôts, railway coaches, and sleeping cars; New Jersey an Act to provide for locating and abolishing mosquito-breeding places; and Virginia an Act prohibiting spitting in public places.

WE have received from the Count Camillo Raineri-Biscia a copy of a reprint of the work entitled "Fior di Pensieri sulle Pietre Preziose di Armed Teifascite" (Bologna: L. Andreoli, 1906), translated from the Arabic and annotated by Antonio Raineri-Biscia. The translation was published originally in 1818, the translator being the eminent professor of Oriental languages at the University of Pisa, who died in 1839. A biography of the translator is given, and of his numerous works there recorded none is of greater interest than this translation of the Arabic manuscript on precious stones by Ahmed Teifascite, preserved in the Royal Library at Florence. The work is divided into twenty-five chapters, each dealing with the formation, occurrence, properties, and value of a different mineral. Some of the minerals are somewhat difficult to identify with certainty, but they appear to be as follows:—pearls, hyacinth, emerald, topaz, balas ruby, amethyst (*benfesc*), garnet, diamond, cat's eye, turquoise, carnelian, onyx, magnetite, corundum, fluorspar (*dahnag*), lapis lazuli, coral, agate, heliotrope (*giemest*), jet (*khamahan*), jasper, rock crystal, and talc. The translation is admirably reproduced, and forms a valuable contribution to mineralogical history.

AS might have been expected, Sir H. Risley's theory that the Bengalis represent a blend of Dravidian and Mongoloid elements with a strain of Indo-Aryan blood in the higher groups has been contested by those members of that enterprising race who claim a higher ethnical origin. The latest critic of this school, Rama Prasad Chanda, deals with the subject in the April number of *East and West* (Bombay). Admitting, as he is compelled to do, that the Bengalis are brachycephalic, he urges that the inclusion in the anthropometrical statistics of partially assimilated races, like the Mals, Koch, and Maghs, unduly increases the ratio of brachycephaly. He proposes a new ethnical classification of the Indian races, including in what he calls the "Outlandic" group tribes of such varied character as Pathans, Baloches, Bengalis, and some races of the Brahmaputra valley, with the population of Coorg and Bellary in South India, all distinguished by round or medium heads, regular features, and moderate stature. In thus excluding a Mongoloid element from Bengal and associating the Bengali with the Turko-Iranian tribes of the North-western Frantier, his views are not likely to be received favourably by competent Indian ethnologists.

A SELECT list of books, with references to periodicals, relating to iron and steel in commerce in the Library of Congress has been compiled by Mr. A. P. C. Griffin (Washington: Government Printing Office, 1907). The list, which covers twenty-four pages, is in no sense exhaustive. It forms, however, a handy guide to the most recent accessible literature of the subject.

IN view of the recent discussion of matters connected with Belgium's exploitation of the Congo, a well-informed paper on the railways of the Upper Congo, by Mr. D. C. Boulger; in the *Engineering Magazine* (vol. xxxiii., No. 4), deserves careful attention. It is a friendly estimate of Belgian enterprise and achievement in pushing the railway

across Africa from the western coast towards the great north and south artery of the Cape to Cairo line. The excellent reproductions of photographs illustrating the article show the difficulty encountered in cutting the track through the dense forest.

THE following interesting details, referring more particularly to the telegraphic weather service of the United States, are taken from the annual summary, 1906, of the *Monthly Weather Review*. The Weather Bureau officials issue forecasts for thirty-six and forty-eight hours in advance daily for each State; the materials necessary for this service, including observations from about twenty stations in the Atlantic and Western Europe, are received by telegraph from about 200 stations in the morning, and from a lesser number in the evening. Storm-warning telegrams are sent to lightships and vessels from all wireless telegraph stations of the navy department along the coasts of the Atlantic, Pacific, and Gulf of Mexico; a similar service has also been inaugurated with the Marconi Company. The immense amount of information received from some 4500 stations of different classes is exhibited to the public in various ways. The daily issue of weather maps in Washington is about 1625 copies; there are also 105 other places, which issue an aggregate of 25,000 maps daily. The number of ships cooperating with the Bureau in the department of marine meteorology was 1771 during the year in question.

THE Munich central meteorological station has for the first time published the preliminary results of the observations made in unmanned balloons in Bavaria in connection with the international ascents. The observations refer to the year 1906, and were made under various conditions, including periods of Föhn winds. The results will be classified for the different types of weather in a later discussion. Below 3000 metres the mean gradient ($\Delta t$/100 m.) was $-0°{\cdot}57$ C., which seems to point to a cooling effect of the mountains on the surrounding air. The largest gradients, $-0°{\cdot}71$, occurred at altitudes of 6000–8000 metres. The lowest point at which the upper inversion occurred was 8000 m., during a barometric depression; the highest point was 13,300 m., during an anticyclone. With one exception the temperature of the warm current in the upper inversion lay between $-51°$ and $-58°$ C. On December 5, in cyclonic conditions, a temperature of $-72°{\cdot}5$ was recorded at 13,270 m.; above this altitude an inversion occurred, and at the highest point, 14,170 m., a temperature of $-63°{\cdot}5$ was registered.

THE extensive use of flexible cord in electric light fittings at the present time makes it of prime importance that definite tests of the rubber on which their insulation depends should be instituted. Prof. A. Schwartz has collected together a large amount of information on the subject, and has added the results of his own experiments in his paper on "Flexibles" in the July number of the Journal of the Institution of Electrical Engineers. He considers that the diagram connecting stress and strain for a complete cycle of stresses applied, which he calls a "hysteresis" diagram, furnishes a better criterion of the character of the rubber than any other test in common use. He is in favour of the use of pure as against vulcanised rubber in flexible cords.

THE hope that the work of Dr. J. A. Harker at the National Physical Laboratory, and of Drs. L. Holborn and F. Henning at the Reichsanstalt, had definitely fixed 1710° C. as the melting point of platinum, has been rudely shaken by the appearance of additional work by Messrs. C. W. Waidner and G. K. Burgess in the May Bulletin of the United States Bureau of Standards, and by Drs. L. Holborn and S. Valentiner in the *Annalen der Physik* (vol. xxii., p. 1). The former, by the optical pyrometer method, find the point is 1753° C., while the latter, by a comparison of the optical scale with the nitrogen scale up to 1600° C., have assigned 1789° C. to the point. These discrepancies show the necessity for further work before the scale can be considered definitely fixed at these high temperatures.

THE current number of the *Quarterly Review* contains two articles of interest to scientific readers. The first, under the title "The Case for the Goat," urges the value of the goat as a producer of milk. "It is not only that the goat produces a relatively large quantity of milk, and exceptionally rich milk, but . . . this milk may be drunk practically without any risk of tubercular infection." The second article, "Magic and Religion," by Mr. Edward Clodd, gives in the form of a review of a number of recent works on anthropology, an interesting summary of the growth of the science, explaining by the way how other branches of natural knowledge have assisted its growth, and enumerating the more recent contributions to the study.

THE Carnegie Institution of Washington has published an "Index of Economic Material in Documents of the States of the United States: Maine, 1820–1904." The work was prepared for the department of economics and sociology of the institution by Mr. Adelaide R. Hasse, of the New York Public Library. The purpose of the volume is to furnish a guide to the economic material contained in the printed reports of administrative affairs, legislative committees, and special commissions of the State of Maine and in the messages of the governors to the legislature of that State. The present volume will be followed by others, each devoted to a single State.

SEVERAL new editions of important German scientific works have recently been received. Prof. Otto Lummer has a volume on optics in Müller-Pouillet's "Lehrbuch der Physik und Meteorologie," the tenth revised edition of which is in course of publication, under the editorship of Prof. L. Pfaundler. The new edition is to be completed in four volumes, and Prof. Lummer's work (price 15 marks), though it runs into nearly nine hundred pages, is only the third book of the first part of the second volume. The publishers are Messrs. F. Vieweg and Son, Brunswick. A second revised edition of "Die Kathodenstrahlen," by Prof. G. C. Schmidt, has also been published by Messrs. Vieweg and Son. The original work was briefly noticed in NATURE of June 9, 1904 (vol. lxx., p. 124); its price is 3 marks. The fifth revised edition of Prof. A. Engler's "Syllabus der Pflanzenfamilien" has been published by Messrs. Borntraeger Bros., Berlin. Two volumes in the Philosophische Bibliothek have been received from the Dürr'schen Buchhandlung, Leipzig; No. 35 is the sixth edition of the German translation of Hume's "Enquiry concerning Human Understanding," edited by Raoul Richter, and No. 113 is a commentary on Kant's "Kritik der reinen Vernunft," by Prof. H. Cohen. Another philosophical work is "Das Weltproblem von positivistischen Standpunkte aus," by Joseph Petzoldt, published by B. C. Teubner, Leipzig. From the same publisher we have received a small volume by Prof. P. Maas, entitled "Lebensbedingungen und Verbreitung der Tiere." Two papers by A. S. Marggraf and F. C. Achard, founders of the beet sugar industry, form No. 159 of Ostwald's "Klassiker der exakten Wissenschaften," published by W. Engelmann, Leipzig.

## OUR ASTRONOMICAL COLUMN.

COMET 1907*d* (DANIEL).—The following set of elements and an ephemeris for comet 1907*d* have been computed by Herr H. H. Kritzinger, of Berlin, from places observed on June 15 and 24 and July 4, and are published in Circular No. 99 from the Kiel Centralstelle :—

*Elements.*

T = 1907 Sept. 4·168 (M.T. Berlin)

$\omega = 293\ 49'16$
$\Omega = 143\ 2'45$ } 1907·0
$i = 8\ 56'37$
log $q$ = 9·71590

An extract from the ephemeris is given below :—

*Ephemeris 12h. (M.T. Berlin).*

| 1907 | α (true) h. m. | δ (true) ° ′ | Brightness |
|---|---|---|---|
| July 24 ... | 3 20·7 ... | +13 37·1 | |
| 26 ... | 3 37·5 ... | +14 21·5 ... | 9·84 |
| 28 ... | 3 54·8 ... | +15 2·5 | |
| 30 ... | 4 12·8 ... | +15 39·4 ... | 11·81 |
| Aug. 1 ... | 4 31·4 ... | +16 11·3 | |
| 3 ... | 4 50·1 ... | +16 37·5 ... | 13·81 |

The brightness at the time of discovery is taken as unity, and it is very probable that the comet will become an easy naked-eye object during August. On July 18 it was easily seen by Dr. W. J. S. Lockyer, at South Kensington, with a small telescope of about 1¼ inches aperture and 11 inches focal length, the brightness on that date, according to the above ephemeris, being 6·38.

According to the ephemeris, the comet on August 1 will be 47*s.* east and 18′ 8″ north of Aldebaran, and will rise four hours before the sun.

ANOMALOUS REFRACTION.—No. 18 of the Miscellaneous Scientific Papers of the Alleghany Observatory contains a note by Messrs. Schlesinger and Blair on the effects of anomalous refraction on meridian-observation results. They show, from a discussion of the results obtained at the international latitude stations, that, at a properly chosen station, the effect is far less than the errors of observation in the best work that can at present be done. Incidentally, their computations indicate very strongly that the Kimura term in the latitude variation is real, and is not due, as has been suggested, to anomalous refraction.

ITALIAN OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE OF AUGUST, 1905.—The various reports which have from time to time appeared in the *Memorie della Società degli Spettroscopisti Italiani*, dealing with the results of the Italian eclipse expedition to Alcalà de Chivert in August, 1905, are now collected into one volume as the complete "Rapporto della Commissione Italiana . . ." With photographs of the instruments in position, reproductions of the solar photographs obtained, and the full discussion of the astronomical and meteorological results, the volume is a valuable addition to eclipse records. Prof. Riccò discusses the colours of the prominences, the heights of the "reversing layer" and of the chromosphere, the white prominences, the corona, the spectra, &c., whilst the discussion of the meteorological results is due to Dr. Chistoni.

MICROMETER MEASURES OF JOVIAN FEATURES.—In No. 4190 of the *Astronomische Nachrichten* (p. 225, July 11) Dr. H. E. Lau gives the results of the observations of Jupiter made at the Urania Observatory, Copenhagen, during the opposition of 1906–7. The measurements of the five bands are first given, and are followed by the dimensions and positions of various "spots" in each band, the longitude and the motion of each feature, at a definite epoch, being appended. For the middle of the Great Red Spot Dr. Lau found the value of $\mu$ to be +0°·071.

JULY AND AUGUST METEORS.—Some valuable hints to meteor observers are given in the July number of *Knowledge and Scientific News* (vol. iv., No. 7, p. 150) by Mr. Denning. The article deals principally with the Aquarid and Perseid showers, both of which should now be active. The former apparently form a fixed radiant point, near to δ Aquarii, from about July 23 to August 23, but this needs substantiating by further careful observations. Mr. Denning suggests that observers should record, very carefully, the exact data for each individual object, and afterwards seek to determine the radiant points quite independently. For the Perseids, and for the Aquarids at their maximum during the last few days of July, the radiant should be obtained separately from each night's observations.

For the minor showers the radiants have never been adequately studied, and many more observations are desirable, whilst even in regard to the Perseids it is probable that a number of important features yet remain to be detected or confirmed. No moonlight will interfere during the maximum of the present apparition.

ORBITS OF BINARY STARS.—No. 5, vol. xxv. (June), of the *Astrophysical Journal* contains discussions of the orbits of κ Cancri and β Arietis by Mr. N. Ichinohe and Herr Ludendorff respectively.

From the discussion of twenty-five plates taken at the Yerkes Observatory, the former observer found the period of κ Cancri to be 3·393 days, whilst the eccentricity of the orbit is 0·149, and the length of its semi-major axis 5,890,000 km.

Seventy-six plates of β Arietis were examined by Herr Ludendorff, but only two lines on each, Mg λ 4481 and Hγ, could be employed in the discussion. The duplicity of the Mg line could not be detected on seventy-four plates, although, as mentioned in a previous paper by Dr. Vogel, it certainly does appear double on the other two. The writer of the present paper suggests that this doubling may be due to special disturbances in the atmosphere of the star. The results of the investigation show that the period of this binary is 107·0 days, the length of the semi-major axis of the orbit is 22,880,000 km., the total mass of the system, assuming that the masses of the components are equal, is 0·34 that of the sun, and that the eccentricity of the orbit has the extraordinarily large value 0·88. No other known spectroscopic binary orbit has an eccentricity greater than 0·55, although the values for several visual binaries exceed 0·80, but in these cases the periods are very much greater.

## SCIENTIFIC WORK IN THE SEA-FISHERIES.[1]

IN the first lecture the earlier history of the pre-scientific period was alluded to, from the third century onward, and even in those early times fears as to the permanence of the sea-fisheries were prevalent, as shown by regulations as to meshes of nets, small or immature fishes, and other features. Indeed, ever-recurring fears as to the decline of these fisheries have been conspicuous. Inquiries and commissions were numerous, and in the seventeenth century many protective Acts were passed, and companies floated to encourage the struggling sea-fisheries, whilst in the eighteenth century the bounty system was instituted and was only abolished in 1830.[2] The Commission of 1833 reported that the fishes of the British Channel had declined since the peace of 1815, and that the fishermen and their families were dependent on the poor-rates for support. It is clear that at that time the finny wealth of the Channel was unknown. The Commission of 1866, on the other hand, came to the conclusion that the supply of sea-fishes was increasing, and admitted of progressive increase. Then the United States Fish-Commission came into existence, from the complaints as to the diminution of the fishes on the American fishing-grounds, and artificial hatching of sea-fishes commenced in 1878. In Britain, again, a commission of two reported in 1878 much as that of 1866 had done.

Lord Dalhousie's Commission of 1883–5 was due to the complaints of the liners against trawling, and it introduced scientific investigation into the subject for the first time. This investigation was made by the same eye and the same hand on sea and on land; a method of dealing with the fishes was adopted, and subsequently followed

[1] Abstract of two lectures delivered at the Royal Institution on May 4 and 11, by Prof. W. C. McIntosh, F.R.S.

[2] An interesting historical account of the sea-fisheries, by D. Fulton, from which part of the foregoing is taken, was given in the *Fish Trades Gazette* for 1893.

in the case of the *Garland's* work under the Scotch Fishery Board. This scientific report gave an account of beam-trawl fishing; the kinds and proportions of saleable and unsaleable fishes; the proportions of the living and the dead and of the immature fishes; the development and growth of the food-fishes; and the universal presence of floating eggs in all the ordinary food-fishes, except the herring and the wolf-fish. It showed that no noteworthy destruction of the spawn of food-fishes occurred, and that the small or immature fishes from the deeper waters consisted chiefly of dabs and long-rough dabs. It gave the distribution of the food-fishes on the various grounds, and the relative condition of the districts; a list of unsaleable fishes (chiefly frog-fishes); the fauna of the trawling grounds—surface and bottom; the food of fishes; temperature of the air; temperature of the surface and bottom water, and other points, including the satisfactory condition of the fishes themselves, and the effects of frequent hauls of the trawl on the same ground. It demonstrated that the inshore was dependent on the offshore for the supply of eggs and young of various fishes; that a gradual passage of the eggs and young shorewards, and of the growing fishes at a later stage seawards, took place. Further, that in a bay like St. Andrews Bay, constant and long-continued trawling did not exhaust the fishes, and that the men invariably kept the same line (by fixed land-marks) in their operations, a feature which at once disposed of the fears as to "trawling out." No interference with well-conducted modes of fishing was suggested.

The scientific report further recommended the establishment of experimental sea-fish hatcheries, the closure of certain areas for experiments, and the keeping of records by all fishermen of the ground, weather, depth, and nature of the fishes. Statistics were put on an improved footing in Scotland. The Fishery Board for Scotland received increased powers and funds, and carried out the trawling experiments in the closed areas, but it did not follow the advice given as to ship, staff, apparatus, and regularity of work. The Board proceeded further to close other areas, such as the Moray Firth, but upon data which science rejects. The Parliamentary Committee of 1893 followed, but the scientific evidence as to diminution was founded on data supplied by the Scotch Fishery Board, and, unfortunately, the faulty method of handling the statistics misled all as to the supposed decrease of flat-fishes. Carefully checked subsequently, the work of the Board's ship *Garland* showed that no increase of fishes had occurred in the closed areas, that the fish-fauna at the end of the ten years' experiments stood very much as at the beginning, and that, on the whole, the marine food-fishes were able to withstand man's interference. Other committees, such as that on the "Immature Fishes Bill" and the "Ichthyological Committee," were also dealt with. Sea-fish hatching was shown to be inconclusive up to date, whilst the enormous numbers of young fishes in the sea rendered the procedure of doubtful advantage.

The whole history of the subject, including the most recent work and statistics in America, Canada, Japan, Newfoundland, Norway, St. Andrews Bay, and elsewhere, showed that it was neither scientific nor practical to doubt the permanence of the British marine food-fishes or the marvellous resources of nature in the sea. Even the lobster (a form supposed to be diminishing) had been shown by Prof. Prince, of Canada, to be able to hold its own in the most rigorously fished district of western Nova Scotia. If such a species can do so, how much more the food-fishes, which survive notwithstanding the distrust of the public and the fishermen, and the fears of the learned as to man's upsetting the balance of nature.

### LECTURE II.

In taking a broad survey of the reasons which prompted our country to join in the International Investigation of the Sea, it would appear that the main object was the prospective benefit to the British fisheries, though the testing of the antagonistic views, viz. of the "Resources of the Sea" and the "Impoverishment of the Sea," may have influenced the decision. The lines upon which such work should be carried out had been laid before the Ichthyological Committee, and subsequently published.[1] It is difficult to ascertain what the British investigators expected to discover, but, briefly, one of their tasks was to find out "whether the quantity and consumption of fish taken from the North Sea and neighbourhood are in proper proportion to the production." To this the observers added the exploration of the small fish grounds. The ambiguity on the subject is apparent from the mention of the "publication of annual results," of "discoveries of practical importance to the fisheries," and of "recommendations for international action."

One department, viz. hydrography, made itself prominent from the beginning, but a study of its work in the German ship *Pommerania* in 1872, of the efforts to connect temperatures with the captures of fishes in 1884, of the observations of the Scotch Board in the eastern and western waters of North Britain, of the International Survey of the North Sea (in which the same Board joined) in 1893–4, gave reasons for reserve. The present results of hydrography in connection with the fisheries in the international investigations emphasise this reserve.

We now turn to the work of the senior naturalists whose efforts were to be directed to the elucidation of fisheries' problems, such as the present condition of the food-fishes of the North Sea, and to prove the "impoverishment of the sea." Briefly, the Marine Biological Association, in the southern area of the North Sea, announces that "facts have been obtained upon which a proper understanding of the yield of the sea must in future be based," and that this pregnant statement rests on the results of experiments with marked plaice. From the numbers subsequently captured three important conclusions are drawn, viz.:—"(1) the migrations of the species, (2) the rate of growth, and (3) the intensity of fishing." Marking of plaice has long been carried out by the Scotch Board, by the Americans with cod, and by the Germans and Dutch in the international work also on the plaice. A simple method of tattooing is suggested as more likely to place the fishes (plaice) on a normal footing than the present somewhat rough one of silver wire and buttons. The data are yet too few and the time too short for a trustworthy conclusion, and British and German observers disagree. The second head has long been studied, and the present observations relate rather to the proportional rate of growth in connection with locality. Thus plaice transplanted from the Horn reef to the Dogger shoal grew faster than would have been the case had they remained, but this increase was exceeded in the Scager Rack. Transplantation is thus suggested by Dr. Garstang, as the Danes have done for some years in the Lim Fjord. So far as experience goes, however, there is little fear of suitable areas off our open shores being left unoccupied by such fishes as the plaice. The third head is apparently considered important by the Marine Biological Association, the percentage captured in the offshore waters being 20 and in the inshore 10, so that it is concluded that a limit has been reached in sea-fishing, and that it is no longer an uncertain pursuit (in the hands of the association). But this conclusion is not supported by long experience in St. Andrews Bay, nor by the history of the plaice-fishery of the Cattegat, nor by the work on the old trawling grounds on the east coast. The international observers, again, differ amongst themselves, the number experimented with being too few for a conclusion so important.

In the northern section hydrographical work is again too prominent, and surprise was felt that a new and original series of fisheries' investigations, based on a well-considered plan, was not forthcoming. The statistics of commercial trawling vessels and their treatment have little real bearing on the present inquiry, even though they are portioned out in Fulton's squares, yet it is asserted "that by these methods, if we only had statistics enough, we should mark down accurately for each fish the time of the coming at every position in the North Sea, and then weaving all the facts together show the route followed in the migration of any species." A tribute may be paid to this enthusiasm, but the importance of all these pages of tables and curves is doubted.

A contribution of a different type is that of the Scotch

[1] "A Second Decade of the Sea-Fisheries," 1903.

Board on "The Distribution and Seasonal Abundance of the Flat-fishes in the North Sea," by Dr. Fulton. This is also largely a statistical paper, and somewhat overlaps Henking's work in the North Sea and the Cattegat, and Dr. Heincke's, so far as flat-fishes are concerned. A main point is the "complementary and compensatory fluctuations" in the statistics, *e.g.* the "witch" or pole-dab in square xiv., near the Fair Isle, taking, during the winter, the place of dabs, lemon dabs, and plaice. Uncertainty, however, exists, as no other method of fishing than trawling was used on the same ground to make sure the other forms were not there. This condition is well known to fishermen. In regard to the maximum of the captures in each fish, it is found that it corresponds to the spawning season. While this paper likewise does not deal directly with the great question handed over to the Scotch Board to solve, it indirectly supports the "Resources of the Sea" in so far as the total average of lbs. per hour of fishing was greater (in flat-fishes) in 1903 than in 1901.

One of the most important papers is that of Dr. H. M. Kyle, who shows that the quantity of fish of all kinds landed in the North Sea ports, and especially of flat-fishes, was greater in 1903 than in 1902. This is clearly substantiated by Johansen's observations on Danish plaice. Hjort's work, again, removes any fear of diminution of round fishes for the supply of the North Sea.

While, therefore, the work of the British international observers up to date does not show an answer to the fundamental question submitted by the Government, yet it inadvertently supports the "Resources of the Sea," and is fairly compatible with the safety of the fishes in the North Sea. Finally, a separate English Fisheries Board, as Lord Dalhousie recommended, was suggested.

## *NEW ZEALAND PETROGRAPHY.*[1]

THE first volume of this work was reviewed in NATURE of January 4, 1906, vol. lxxiii., pp. 234, 235. We noticed in that place the reasons which led to these Cape Colville rocks being selected for special study, and also the circumstances which made it necessary to call in extraneous aid for the descriptive part of the work. Of the volume now before us, the first two-thirds, to which alone the title of the book is properly applicable, completes the account of the volcanic rocks of the Cape Colville Peninsula. As before, the petrographical descriptions are by Prof. Sollas, and the notes relative to locality and occurrence by Mr. McKay, who also furnishes a clear geological map of the district. The details of mineralogical composition and micro-structure do not include much that is new, though we may mention the occurrence of a felspar of the anorthoclase type in some of the rhyolites, the frequent association of hornblende (or its pseudomorphs) with hypersthene in the andesitic rocks, and the presence of olivine in certain basic hypersthene-andesites or hypersthene-basalts. The interest of this collection of Tertiary andesites, dacites, and rhyolites lies, not so much in any novelty which they present, as in the close resemblance of the whole assemblage from this "petrographical province" to familiar types from better-known areas, such as Hungary and the Great Basin of North America.

The lack of arrangement and some minor blemishes, on which we will not insist, are drawbacks doubtless incidental to the conditions under which the work was carried out, by the cooperation of a petrologist in England with a field-geologist at the Antipodes. When this investigation was taken in hand, Mr. McKay, we believe, embodied in his own person the Geological Survey of New Zealand, and the work must be considered a notable production in these adverse circumstances. The re-organised Geological Survey, under the directorship of Dr. J. M. Bell, has begun operations with greater advantages, and two important memoirs of the new series have already appeared.

A special feature of the present work is the profusion of plates. This was not, we understand, a part of the original design, but it greatly enhances the value of the book. In the two volumes more than two hundred full-page plates are devoted to the illustration of the volcanic rocks of the Cape Colville Peninsula alone. The thin slices have been photographed with polarised light, usually with an amplification of sixty diameters, and most of the plates are very successful in rendering the micro-structure of the rocks selected. Such a collection of illustrations is welcome independently of the immediate object of the book, and the fact that most of the rocks belong to types of world-wide distribution is, from this point of view, an advantage.

The latter part of this volume is devoted to the description and illustration of various rocks from numerous places in New Zealand. Some of these, from the Kaimanawa Mountains and other localities in the North Island, are volcanic rocks generally comparable with those of Cape Colville. Other descriptions are included here, without regard to relationship, to fill out the volume, and the want of any orderly arrangement gives a somewhat confused appearance to this section. Some remarkable teschenites are described from the east coast of Wellington Province. They appear to occupy the neck of an old volcano, and it is noteworthy that, like the similar rocks from some European localities, they are referred to a Cretaceous age. Special interest attaches to a collection of crystalline schists from Westland Province, on the west side of the South Island. In addition to garnetiferous mica-schists, epidote-amphibole-schists, and other ordinary types, there occurs a series of schistose ultrabasic rocks composed of serpentine, talc, tremolite, calcite, &c. Through the same district there runs also a belt of massive ultrabasic rocks, viz. fresh and altered dunites. The geological relations of these two very interesting groups are only briefly touched in this work, but they are fully discussed in the first Bulletin (new series) of the Geological Survey, already mentioned.

Prof. Sollas's investigations, while devoted mainly to the exhaustive description of one group of rocks, afford also a glimpse of the rich variety of material which New Zealand offers to the petrographer. When we recall further the widely different "petrographical province" of Dunedin, characterised by highly alkaline rock-types, some of which have recently been described by Dr. Marshall, we may expect that a more comprehensive examination of the igneous and crystalline rocks of the colony will result in further important additions to petrological science.

A. H.

[1] "The Rocks of Cape Colville Peninsula, Auckland, New Zealand." By Prof. Sollas, F.R.S.; with an Introduction and Descriptive Notes by Alexander McKay. Vol. ii. Pp. 215; with geological map and 133 photographic plates of rock-sections. (Wellington, N.Z.: J. McKay, 1906.)

## *UNSOLVED PROBLEMS IN THE DESIGN AND PROPULSION OF SHIPS.*[1]

THERE are but few problems in the design of ships, as in most other branches of engineering, that can be exactly or completely solved in the full scientific meaning of the word, and those are of a secondary character. The primary or fundamental problems of safety, strength, speed, and steadiness at sea are far too complicated to bring under anything like general mathematical treatment. The results obtained by the most advanced calculations cannot be applied directly to the real conditions of a ship at sea. After all is said and done, they merely relate to hypothetical cases which are simple in character and are amenable to mathematical treatment. Some of these calculations are very elaborate, and their elaboration may sometimes tend to magnify their importance. The real problem is often very imperfectly dealt with after they are made, and it can only be solved approximately for working purposes by accepting the results of calculation for what they may be really worth, judging of the allowances required for their incompleteness, and using them in a scientific way and a scientific spirit to arrive at safe conclusions. We are obliged to come to a conclusion somehow, because we have to build ships as well as we can, whether we can solve exactly all the problems that arise in their design or not; and we have to take the responsibility of guaranteeing results, however difficult to obtain, or of declining to do so, within the time allotted for the preparation of

[1] Abridged from the "James Forrest" Lecture, delivered before the Institution of Civil Engineers on June 18, by Dr. Francis Elgar, F.R.S.

designs and tenders, which is often very short. This is of the nature of engineering work of all kinds.

The nature of some of the principal problems that arise in the design of ships, and the extent to which their solutions are scientific, empirical, or merely tentative, will be indicated in some degree as I go on. I pass over what I venture to call the secondary problems of mensuration and hydrostatics—which relate to bodies floating in equilibrium in still water, and constitute the bulk of the ship-designer's purely scientific stock-in-trade—and will endeavour to direct attention to some of the fundamental problems of a ship's behaviour at sea. I do not underrate, however, the great importance of those passed over, for it is the results of mathematical and physical research into the still-water properties and conditions of floating bodies which enable us, with the aid of observation and experience, to judge the probable qualities and behaviour of ships at sea. They also furnish the best data for comparisons between ships of varying dimensions and forms.

The class of problems that demand attention first are those which bear the most directly upon safety at sea. These are very general and comprehensive in character, and are impossible of anything like complete solution from the purely scientific side; but they are of vital importance, and solutions of them, which will be upon the right side, have to be found somehow for every ship that is built.

The first in natural order of the problems that relate to safety is the maximum depth of safe loading, or the minimum sea-going freeboard for a ship of any given size or type.

The losses of cargo-steamers, and of lives at sea, became so serious twenty-five to thirty years ago that many attempts were made to get a law passed for limiting depth of loading. The great difficulty and complexity of the problem resisted for a long while all efforts to deal satisfactorily with it. It was considered by many authorities, upon all sides, to be impossible of solution; and yet individual shipowners, or shipping companies, were obliged to regulate the loading of their own ships in some way, and upon some system, or make it the duty of others to do so. It followed, therefore, that if the knowledge and experience of those separately responsible for the loading of the various types of vessels could be brought together and analysed, it ought to be possible to frame rules and tables of freeboard which would embody the results of safe loading, and prevent steamers being sent to sea in a dangerously overladen condition.

The present Board of Trade freeboard rules and tables, which limit, by an Act of Parliament passed in 1890, the depth of loading of British ships, were arrived at in this manner. The first official tables were prepared in 1885 by a committee appointed by Mr. Chamberlain when he was President of the Board of Trade.

The close attention paid during recent years to the protection of openings in the weather-deck, in association with the strict limitation of loading now enforced by the Board of Trade freeboard tables, has resulted in an extraordinary diminution of losses at sea. The effect upon safety of the present regulations, and of the improvement all round in the size, strength, and equipment of ships is shown by the yearly statistics of losses, and it is well that the figures relating to these should be known. In the three calendar years 1881–3 there were 1982 of the British ships registered in the United Kingdom, exclusive of fishing-vessels, lost at sea from all causes—foundering, stranding, collision, and missing—and 5599 lives of crew in them, besides 332 passengers. For the three years ending June 30, 1906, the corresponding figures were 654 ships, 1394 lives of crew, and 133 passengers—and more than 100 of these passengers were lost in the channel steamer *Hilda*, on her passage to St. Malo in November, 1905. The number of lives of crew lost at sea has thus been reduced to one-fourth of what it was twenty-five years ago, while not more than thirty passengers, besides the unfortunate victims of the *Hilda* disaster, lost their lives in all the vessels, large and small, that were lost at sea during the three years ending June 30, 1906.

An important element of safety at sea is the division of the hull into separate water-tight compartments. A collision with another ship may occur, and it is necessary to provide, in such case, against being sent quickly to the bottom. Much attention has been given to this point during recent years, especially in large passenger liners. The number and positions of the water-tight bulkheads in these are often regulated so as to carry out the recommendations of the Board of Trade Bulkheads Committee, presided over by the late Sir E. J. Harland in 1891.

Compliance with the Bulkhead Committee's rules is optional on the part of shipowners, but, although they may be sometimes used as a guide in fixing the position of bulkheads, full compliance with their requirements is by no means general, even in the highest class of steamers.

The next point of vital importance to safety at sea is stability. The stability of a ship when floating in equilibrium in still water is readily calculated, and is represented graphically by curves which show at any angle of inclination what the righting moment is which operates to move her back towards the upright position supposing her to have been forcibly inclined away from it. It is thus determined very completely for the assumed still-water conditions, but the designer, although he is obliged to trust to his judgment for making it satisfactory for sea-going purposes, often knows little of what it may become under working conditions upon a voyage. I made two voyages in a large ocean liner not long ago, the metacentric height of which is about 7 inches when light and 18 inches when filled up with passengers, stores, fresh water, coals, and a homogeneous cargo of such density as completely fills all the cargo spaces and immerses her to her load draught. The metacentric height was 2 feet 2 inches at sailing upon the first voyage; at the middle of the voyage it was 21 inches, and at the end 20 inches. Upon the second voyage the metacentric heights were 2 feet 10 inches at starting, 16 inches in the middle of the voyage, and 20 inches at the end. The irregularities in the metacentric height from day to day were largely due to the manner in which the water-ballast was used. This was the case of an ocean liner, in which the weights carried were about one-half the fixed weight of the hull and machinery. In a large cargo-steamer, where the weights carried may amount to twice the weight of the hull and machinery, it will be seen how much the stability on service depends upon those who regulate the loading, and how little upon the designer.

The ship-designer requires to decide, of course, what metacentric height to give a ship in the circumstances to which his calculations apply, but it is only by comparison with other ships of similar types that have been found satisfactory after passing into the hands of their owners that he can properly fix the exact figure.

The question of stability was raised before the Loadline Committee of 1885 in connection with the regulation of freeboards, and has often been revived since. It has been felt, however, that stability is so intimately related to stowage, and so much in the hands of those who regulate it, that it would be impossible to treat stability satisfactorily as a mere factor of depth of loading. Nothing can make a ship safe if her stability is not secured by proper stowage; but when vessels will obviously admit of being loaded with homogeneous cargoes, so as to have their stability dangerously reduced at sea, the official bodies who assign load-lines should look for proof that the danger is understood, and that proper measures will be taken in regulating the stowage to guard against it. I understand this is the course taken by the Board of Trade and the authorities who assign freeboards when cases of such a nature come before them.

One of the most important elements of safety at sea is structural strength, and there is no more intricate or difficult problem which we have to consider. Mercantile steamers have been made what they are, in respect of design and strength of structure, chiefly by observation and experience of the effects of straining action at sea. The usual calculations of strength of structures do not carry us very far by themselves in shipbuilding, and although much attention has been given to these by ship-designers they cannot be greatly relied upon in practice. As a matter of fact, the arrangement of material shown upon the transverse section of a ship, and the sizes of the various parts, are practically what they have been made

from time to time by Lloyd's Register Society. Classification at Lloyd's is so important in the mercantile marine for purposes of insurance that the design of a ship's structure is usually little, if any, more than compliance with Lloyd's rules and tables. These rules have been modified as ships have increased in size and varied in type; and when exceptional ships not directly provided for by the rules have to be classed, the structural design is specially dealt with by Lloyd's; but the governing principle throughout is experience of the behaviour of ships at sea.

Lloyd's Register Society has also done, and is still doing, much in the way of scientific research. It has a highly trained technical staff which has conducted and published some of the most valuable investigations yet made of the structural strength of ships; but the general problem of how to obtain the requisite strength of structure with the minimum weight of material is extremely difficult of approach from the scientific side. The usual calculations of structural strength are based upon still-water conditions. The most important are those which relate to longitudinal strength, because the greatest stresses that can come upon a ship are in the longitudinal direction. In these calculations the structural portion of the hull is regarded as a steel girder supported over the whole of its length by the upward pressure of the water.

In order to approximate somewhat to the worst conditions at sea, the maximum stresses at the top and bottom are calculated for two hypothetical cases of support upon a wave surface. The surface usually taken is that of a trochoidal wave of the same length as the ship, the height of which is one-twentieth of its length. The vessel is first considered in equilibrium upon a wave-crest with her bow and stern in the adjacent hollows, and next to be supported at the ends upon two wave-crests with her midship part in the hollow between them. The whole system of wave-water is supposed, for the purposes of the calculations, to be fixed for the moment, and the ship to be floating upon it in statical equilibrium.

It is not known how nearly the results given by calculations, which rest upon assumptions that differ so widely from the real circumstances, correspond with the maximum stresses really brought to bear at sea, but it is certain that they are often much in excess of the truth. In the new big Cunarders, *Lusitania* and *Mauretania*, the limiting stress accepted by Lloyd's as determined by calculation was 10 tons per square inch for mild steel the ultimate tensile strength of which is 28 to 32 tons per square inch. This gives an apparent factor of safety of only 3.

Many vessels have been running for years in which the figures, obtained by similar calculations, for the maximum stresses would amount to 10 tons per square inch. This must be largely in excess of the truth, and it is impossible to say exactly by how much.

The quantitative values of the calculated stresses are thus extremely doubtful. Even in comparing them with figures obtained in a similar way for other ships, it is necessary to be careful not to press the comparison too far. Attempts have been made to measure the actual stresses at sea upon portions of a ship's structure by means of strain indicators. Extensive experiments were carried out in H.M.S. *Wolf* a few years ago by an Admiralty Committee with Stromeyer's indicators, which gave some interesting results; but very little real progress has yet been made towards a quantitative solution of the strength problem.

The *Great Eastern* proved, by her Atlantic voyages to New York and Quebec, and her subsequent experiences in the trying work of cable-laying in the Atlantic, that she was quite strong enough for anything required of such a ship; and if we compare her structure with that of the standard ship of her dimensions and type to-day, which embodies the results of fifty years' more experience than her designer had at command, it appears very remarkable. Sir W. White came to the conclusion, which I believe is right, that after making full allowance for features of modern designs, that involve additional weight, which the *Great Eastern* did not possess, her structure was lighter than that of the corresponding ship of to-day, although the ship of to-day is built of steel 50 per cent. stronger than the iron plates of the *Great Eastern*, and the riveting of the edges and butts of plating is much more extensive and efficient, and is performed by hydraulic power in those parts where strength is most important.

The difference in principle between the two designs is so great, and the comparison of the weights of material they require is so much in favour of the *Great Eastern*, that there certainly seems to be a case for careful investigation, and for seriously considering whether a radical change in the structural design of large ocean liners might not be made with advantage. Novel structural arrangements are constantly being introduced into the design of cargo-steamers in order to give large open holds and to facilitate stowage. Some of these are now being built of large size and depth, with only a single strongly plated deck at the top, and there seems no reason why this principle should not be applied to large passenger vessels. Any saving of weight thus effected would not only be a saving of cost, but would better enable the difficulties of draught of water in harbour and docks for the largest ships to be overcome.

The problem of speed has always been a very vexed and difficult one, and there is none which has caused more trouble, or given rise to more fallacies in theory and errors in solution. I cannot even direct attention to the numerous theories and the various approximate formulas that have been invented and employed from time to time for explaining and solving the speed problem. These formulas are generally so restricted in their range of application, and require so much knowledge of their limitations and the conditions under which they can alone be relied upon for results that will be approximately near the truth, as to prove dangerous traps to the unwary and ill-informed. The man who can use these intelligently and safely, and with full knowledge of their limitations and their tendencies to error, is able to deal with the speed problem much more completely and effectively—and I shall confine my remarks to the way of doing that.

The practical solution of the speed problem was effected by the late Mr. William Froude when he discovered the law of similitude or comparison which enables the resistance of a model, as ascertained by experiment, to be used for calculating the resistance of another model upon a different scale, or that of a full-sized ship of similar form. His analysis of the separate elements of resistance, showing that the two great ones, friction and wave-making, varied independently of each other, and the latter in a very irregular manner, explained why simple approximate formulas are so untrustworthy.

What is wanted for the practical purposes of a designer is the means of ascertaining the resistance of a ship of given dimensions at any desired speed; and also of readily determining the precise form or degree of fineness of under-water body that would enable the maximum of carrying power to be obtained at a moderate rate of fuel consumption. It is one thing to know exactly what power is required to give a ship of given dimensions and form the speed asked for or promised, and quite another to determine what are the dimensions, form, and degree of fulness that will give the maximum passenger and freight-carrying capacity with moderate engine power and expenditure of fuel.

In order to exhaust the problem of the best form of ship to meet the requirements of any particular trade or service, considerable investigation is required. This can only be made satisfactorily by testing the resistances of models in an experimental tank upon the late Mr. Froude's system.

That method is unfortunately impracticable, however, for ship-designers in this country, because there is no experimental tank here available for general use. The very few that exist belong either to the Admiralty or to private shipbuilders, and are confined exclusively to the work of their respective owners. I have had experiments made occasionally for my own purposes, but had to go abroad for them. The experiments required by Mr. Yarrow for his valuable investigations into the effect of shallow water upon speed were made in the North German Lloyd tank at Bremerhaven, where other experiments have also been made for him. A British shipbuilder can only get such experiments made by setting up an independent establishment for himself or going abroad. Now an experimental tank, with its equipment and a competent staff for work-

ing it, is very costly to create and to maintain; and over and above the cost of construction, and of running it, there is the all-important question of the quality of the results it will produce. It is not enough to procure a tank with all its apparatus and appliances and to attach to it a staff of scientific men to run models and take records of their speed and resistance. The work is of so delicate and intricate a nature that the personal qualities of the experimenters count for very much in it. The results obtained by the late Mr. W. Froude and the present Mr. R. E. Froude owe much of their value to the exceptional qualifications of those eminent men for scientific research, especially upon the experimental side. It is the men, and not the tools, who constitute the most important factor in work such as this, and the right men for it are very difficult to obtain and to keep.

An attempt has recently been made to provide an experimental tank at the National Physical Laboratory, to be worked by members of the staff there, at which ship models might be tested for resistance, but up to now this has been without result. There is another way of dealing with the matter, however, and a readier one for the ordinary purposes of the ship-designer, which has been initiated by Mr. R. E. Froude, that promises to overcome the difficulty in a satisfactory manner. Mr. Froude read a paper at the Institution of Naval Architects, three years ago, upon "Some Results of Model Experiments," in which he gave results of a series of general experiments on systematic variations in form of hull, the variations consisting of six different sets of typical lines, varied in proportion by independent variations of length, beam, and draught. The resistance data given by these experiments are published in the paper in such a form that the resistance of a ship of any dimensions, the lines of which are similar to the typical ones, which are also given, can be readily taken out. The types dealt with have block coefficients, or ratios of displaced volume to product of length, breadth, and draught, varying from 0·4865 in the finest to 0·541 in the fullest. Now this covers a very important class of mercantile steamers—that of fast Channel boats—and the designer of such a boat could have nothing better for his speed calculations than the data in this paper. He has only to refer to Mr. Froude's tables and diagrams in order to determine at once the proportions and form that will best suit the circumstances, and to construct the lines of his boat.

If similar data could be obtained for other forms of ships, say for the fast-liner type, with block coefficients varying from about 0·6 to 0·7, the designer of that class of vessels would indeed have cause to be grateful. The best practical solution of this long-vexed problem of the relation of power to speed appears to be an extension of Mr. Froude's system to vessels of the fast-liner type, and to others with which the ship-designer ordinarily has to deal, leaving those of abnormal proportions or form, and also the work of general research, to a public experimental tank—if ever we find enterprise enough among those interested to get one set up in this country.

The resistance of a ship may be estimated to a close degree of accuracy in the manner mentioned, but the determination of the engine power required to overcome that resistance involves the important consideration of screw-propeller efficiency. The problem of the most efficient design of propeller for any given size and form of ship and rate of turning of shaft is as yet far from practical solution. Model experiments have been carried out at Haslar with a large number of propellers of varying pitch, diameter, and developed area, but these model screws have been very small, as the size and speed at which they could be worked were limited by the stresses the experimental mechanism is capable of bearing.

Further advance might be effected by carrying out experiments on a larger scale than those already made, and with stronger appliances than those now used for the purpose in the Admiralty tank. A still more effective means, which I hear is under consideration by Mr. Froude, would be to build an experimental launch for the purpose, to be run in open water and propelled by machinery of considerable power. The propelling machinery could be so arranged that the thrust of the screws and the torque on the shaft would be automatically recorded, as in the case of tank experiments. With such an arrangement screws up to 3 feet in diameter could be experimented with—a great advance on anything that could be hoped for in the tank—and the important problem of propeller efficiency might thus be brought much nearer to a practical solution.

We now come to the greatest problem of all with regard to the propulsion of ships, and that is the form which propelling machinery is likely to take in the immediate future. Already an important change is in progress from the ordinary reciprocating marine engine to the steam turbine, and the question is not only how far that change will extend, but whether the whole of the cumbrous apparatus required for producing steam may not before very long be swept out of mercantile steamers, and the power be obtained from some form of internal-combustion engine. Very few ocean steamers have been fitted with turbine machinery or are being so fitted, and although this may not cause surprise in the case of cargo-boats and other vessels of low or even moderate speeds, it may appear strange that liners of high speeds are still being fitted with reciprocating engines, and that the bold lead given by the Cunard Company with their two fastest new boats and the *Carmania* should not be generally followed.

The chief reason for hesitation to put turbine machinery into ocean liners is the doubt which exists as to coal consumption. The amounts at stake are so large in these costly vessels when experiments with novel propelling machinery are tried that everybody prefers to see someone else make them. The Cunard Company is making the crucial experiment upon the largest scale that is now possible, and everyone interested in progress must wish those responsible for it all the success they hope for and deserve; but the result is to some extent uncertain, and the immediate future of the turbine in fast liners depends greatly upon it.

In warships the consumption of coal has been brought down to about 1·7 lb. per equivalent I.H.P. of reciprocating engines per hour, and the same in mercantile boats of cross-Channel type. That is as good as can be obtained with reciprocating engines in the same classes of vessels, as weight has to be kept down as much as possible in these by shortening the stroke, and using high mean pressures of steam in the cylinders, in order to get all the power that is practicable out of a moderate size and weight of machinery. It pays better, in these cases, to stop somewhat short of the maximum efficiency that is attainable than to carry the additional weight which the increase would involve. In ocean liners the conditions are different, and economy of consumption is there the chief point aimed at. Their consumption with quadruple-expansion engines and a boiler pressure of 210 lb. to 220 lb. per square inch has been brought down to 1·3 lb. of coal per I.H.P. per hour for all purposes. The substitution of turbines for reciprocating engines in ocean vessels depends chiefly upon whether the consumption with turbines can also be brought down to this low figure, and there is no satisfactory evidence that this is now practicable. It appears probable that the marine turbine may ultimately be so improved as to beat the best reciprocating engines in economy of consumption in ocean liners, but no proof is forthcoming that it can yet be relied upon to do it.

The correct measurement of the power given out by turbine machinery is a practical problem of great importance. Considerable success has been achieved with a telephonic recording apparatus for indicating the twist of a shaft over a given length, and thus giving a measure of the torque. The record is not always, however, so definite and accurate as could be desired. A satisfactory solution of this problem is much required by ship designers.

The question of some form of internal-combustion marine engine suitable for large ocean vessels is still about where it was when Mr. Milton's paper was read and discussed here last January, and I do not feel able to add anything with advantage now to that paper and discussion. I will therefore merely enumerate the conditions, most of which were mentioned by Mr. Milton, that must be satisfied by a successful marine engine of any type whatever:—

(1) The engine must be reversible.

(2) It must be capable of being stopped quickly, and of being started quickly either ahead or astern.

(3) It must be capable of being promptly speeded to any desired number of revolutions between dead slow and full speed, and of being kept steadily at the required speed for any length of time. "Dead slow" ought not to be faster than one-quarter of full speed, and should be less in very fast vessels.

(4) It must be capable of running continuously for long distances, with but short intervals between the runs, without risk of stoppage or breakdown.

(5) It must be capable of working well, not only in smooth water, but also in heavy weather in a seaway, where the varying immersion of the propeller causes rapidly changing conditions of resistance.

(6) All working parts must be readily accessible for overhauling, and all wearing surfaces must be capable of being promptly and easily adjusted.

(7) The engine must be economical in fuel, especially at its ordinary working speed.

(8) It must be compact, light in weight, and well balanced so as not to cause vibration.

(9) It must not involve any risk of accumulation of gas in the ship such as could form an explosive mixture.

(10) It is a *sine qua non* that it must be capable of using a fuel the supply of which at moderate price is practically unlimited, and that could be obtained readily in whatever part of the world a ship might happen to be.

Engineers and metallurgists may together succeed in overcoming some day the difficulties of producing large cylinders which will stand the high impulses and great and rapid variations of temperature that occur with internal combustion, but until that is accomplished no great step ahead can be taken. There are no two opinions, however, as to the advantages that would be gained by doing away with the present boilers and their appurtenances, and abolishing with them much of that very arduous and disagreeable class of labour known as marine stoking.

The subject of oil fuel for marine boilers is interesting, but I have no time to say more than that great practical advance has been made with it during the last decade, and a consumption as low as 0·9 lb. per I.H.P. per hour has been regularly realised in mercantile vessels which employ the system of spraying the liquid for combustion by means of hot air. American steamships have used oil fuel largely during the last three years, under a combined system of high and low pressure air respectively for desiccating or pulverising the oil before combustion and for assisting the combustion afterwards. This system has proved highly successful and economical. Vessels of 14,000 tons displacement belonging to the Shell Transport Company have made voyages regularly and successfully from Singapore to this country by the long route of the Cape of Good Hope, and still larger vessels have made equally successful voyages from New York to San Francisco *viâ* Cape Horn.

The securing of all the comfort that is possible for passengers on board ship is a modern idea. Formerly it was thought sufficient to take them safely, and without much regard even to time, to their destination, and very little attention was paid to comfort. Now it is the chief object of the best shipping companies to leave and arrive in port on fixed days, and even at fixed hours, and to make the life of passengers on board ship as comfortable and luxurious as on shore.

Much of the comfort and luxury now in such demand by passengers is provided by those who manage the ships, and not by their designer. There is one very important element of comfort, however, which the designer can do much to supply, and to which increasing attention is given. I refer to steadiness at sea, and freedom from heavy rolling and pitching. But whatever may be done by the designer to give a metacentric height favourable to steadiness, its proper regulation at sea by suitable stowage of cargo and stores in the first instance, and by the judicious use of water ballast afterwards, requires the careful and close attention of the ship's officers if unpleasant rolling is to be kept at a minimum. About 18 inches of metacentric height appears to give a satisfactory combination of resistance to inclination in large ships with a long rolling period.

After reducing the tendency to roll as much as possible by suitable regulation of the metacentric height, the next thing is to increase the resistance to whatever rolling there may be. This is done chiefly by means of bilge keels, which oppose the whole of their surface to the motion of rolling, and are very effective in reducing its extent when they are of sufficient depth. In ships I have known that have been fitted after they were built with bilge keels suitably formed and placed, the extreme angles of rolling have been reduced to one-half. Their steadying effect is now well known and admitted in the mercantile marine.

Other devices have been considered, and some have been tried for still further increasing the resistance to rolling. Sir Philip Watts described in the Transactions of the Institution of Naval Architects for 1883 and 1885 the trials in H.M. ships *Inflexible* and *Edinburgh* of free water in large chambers that extended right across the lower deck, the transverse motion of which, as the ship rolled, was regulated by the shape of the water-chamber and the depth of the water, so that it would operate as a drag or brake upon the rolling motion. The same device was tried in a small passenger ship, the *Ohio*, in 1887, and in the *City of New York* and *City of Paris* in 1889. In the two last-named ships the chamber was upon the orlop deck. These water-chambers appear to have given good results within certain limits of rolling and when the motion of the water in them was well timed, but the action upon the rolling depended very much upon the way in which the water was regulated. Whether it was on account of this or because of the space occupied, or other objections that exist to the free motion from side to side of large quantities of water in a ship, I do not exactly know, but whatever the reason may be the idea has been dropped.

A proposal has recently been made by M. Victor Cremieu, of Paris, to check rolling by means of a heavy pendulum of long period that would oscillate in a closed chamber filled with viscous fluid, and he has contributed a paper upon the subject to the Académie des Sciences. His idea is to make the length of pendulum and its weight such as would give it an angular moment up to possibly one-tenth that of the ship. The clearances between the pendulum and the sides of the chamber, and the degree of viscosity of the liquid—M. Cremieu suggests oil, or a mixture of water and glycerin—would be so arranged as to make the energy of the pendulum most effective in offering resistance to rolling. A simplification of the apparatus is suggested by substituting for the pendulum a weight that would move backwards and forwards upon a curved path in a transverse chamber or tube filled with the viscous liquid. In both cases the principle is that of opposing the rolling of the ship by the statical moment of the oscillating weight, and reducing the energy of motion by generating heat in the fluid through which the weight moves.

Sir John Thornycroft described an automatic steadying apparatus in 1892, which was fitted in his steam-yacht *Cecile* with some success. It consisted of a most ingenious controlling gear which regulated the motion from side to side of a heavy weight in opposition to the rolling motion. It was very cleverly worked out, and destroyed much of the rolling in a vessel of great metacentric height and very short period. This idea also has not been followed up.

A device which appears promising for increasing the resistance to rolling is one that has been ingeniously and effectively worked out by Dr. Otto Schlick, of Hamburg, a very eminent marine engineer. It depends upon gyroscopic action, and its principle was fully described by Dr. Schlick at the Institution of Naval Architects in 1904. This principle appears to deserve serious consideration, and is already ripe for application to the smaller classes of steamers. I am informed that an apparatus is being manufactured for placing in the Hamburg-American Company's passenger-boat *Silvana*, of about 1000 tons, which runs between the Elbe and Heligoland, and that Dr. Schlick is designing a standard gyroscope that will be suitable for

boats of about 1200 tons to 2000 tons displacement. This standard gyroscope will be electrically driven, except in cases where there is not a sufficient margin of electric power available in a ship, when it would be driven by a steam turbine. An apparatus for vessels of the displacement named would be applicable to the class of Channel steamers, and we may perhaps see it tried before long in some of them.

What I have said with regard to making ships steady at sea has had reference only to rolling motion; but many persons consider it is not rolling that affects them so much as pitching, or as the skew motion near the ends of a ship that is neither rolling nor pitching, but an unpleasant combination of the two. There is also sometimes a vertical or heaving oscillation when large waves are passing a ship broadside on which may rise to an amplitude of several feet when the wave-period approximates to the period of her own dipping oscillations, but it is probably seldom that the motion from this cause is great. Pitching is often the chief cause of trouble and discomfort, and the motion due to it may be greater and more violent than any other, especially near the ends of the ship. The pitching period is sometimes as short as four seconds, so that there may be three or four pitches to one roll; and the vertical distance moved through near the ends in pitching is very much greater than at the ship's side during a roll.

After all has been done in the way of making the forward transverse sections of a ship such as will best resist plunging into the sea, and by good stowage, there still remains considerable tendency to pitch in certain conditions of sea which cannot be removed. The best way to avoid the ill effects of pitching is to get as near as possible to the axis of rotation, the position of which varies considerably according to the nature and direction of the seas which cause the pitching, but is, on the average, not far from the centre of length. The modern large steamers which have their first-class passenger accommodation upon three or four decks in the middle third of a ship's length are generally found to be the most easy and comfortable at sea. That is no doubt largely because the greatest vertical distance moved through in pitching in the passenger accommodation is only one-third of what it is at the ends of the ship. It is to this concentration of passenger accommodation near the middle of a ship's length that we have to look chiefly for neutralising the trying effects of pitching.

One of the chief causes of discomfort and distress to passengers on shipboard is vibration. This may be due to one or more of several causes, to which much attention has been given during recent years. The effect of reciprocating engines in causing vibration has been investigated by Dr. Schlick, Mr. Yarrow, Mr. Mallock, Prof. Dalby, and others, who have demonstrated the manner in which such engines operate to cause vibration, and how to reduce this effect to a minimum by suitable design, and by balancing the principal working parts. There is little to choose, in a strongly built ship, between modern well-balanced reciprocating engines and steam turbines as regards smoothness of running and absence of unpleasant vibration. Vibration is often due to the action of the propellers, and when these have to run at very high speeds, as with fast-running turbines, a certain amount of vibration is sometimes unavoidable. Apart from the essential conditions of trueness of propeller blades and exact balance of the propellers upon their shafts when turning, there is the action of the ends of the blades upon the water adjacent to the stern-plating where they pass nearest to it in revolving, which causes a hammering effect that is sometimes very great. The vibration and tremor of this plating may be quite local, and may be readily checked by strong bracket frames at the part where it is greatest; or it may be communicated throughout the hull, and set up sympathetic vibrations in large flat areas of plating, such as decks, straight side-plating, bridges, &c. These difficulties can generally be overcome by careful attention to the surfaces that vibrate, and by stiffening or supporting them at a few critical points by struts or brackets. There appears no reason why ships should not now be kept free from all unpleasant vibration, whether as regards the working of the main engines or the action of the propellers.

The tendency to increase the size of ships is strong and continuous. It has long been known, and experience proves that the power required to drive a ton of a ship's displacement at a given speed diminishes, and the working expenses become less per ton all round, with increase of size.

There is a size and speed of ship that is most appropriate and profitable for each line of steamers, or each trade, and it varies greatly in different trades. It is the managers of the various lines who know best what dimensions and speed are likely to be most profitable in their respective trades, and what are the maximum number of passengers and quantities and descriptions of cargo likely to be forthcoming. The approximate size, and the speed, of mercantile steamers depend upon commercial and economic considerations which the ship-designer usually has but an imperfect knowledge of. His part consists in producing a design that will fulfil the necessary conditions of size, draught of water, speed, carrying capacity, and accommodation for passengers in the most efficient manner and at the minimum of cost. There is one point, however, which is so important in considering further large increases of speed in ocean liners generally that I would like to direct attention to it.

Speed is limited in passenger liners, altogether independently of size, by economic considerations. High speed at sea is a costly luxury. It can be obtained by paying for it—up to 25 knots, as we see by the latest Cunard liners—but it has to be paid for by somebody. The extra cost cannot be got out of cargo freight, for as speed is increased the proportion of space available for carrying cargo becomes reduced by the increase of boilers and machinery, and therefore less cargo is carried relatively to the size of the ship. This reaches an extreme limit in the fastest Atlantic liners, the holds of which are as full as they can be stowed of engines, boilers, and coals for the voyage—their speeds only being limited by the impossibility of getting more boilers in—and it is only a few odd spaces which cannot be utilised for other purposes that are available for carrying a little cargo. In these cases cargo is reduced almost to a negligible quantity.

It may be said generally, as regards any line of steamers, that if speeds of more than 12 to 13 knots are desired the extra expenditure involved by such increase must be looked for outside the cargo. This element of earning power does not bear an increase of rate of freight. There are only two sources from which payment of the extra cost of increased speed can come. One is from passengers and the other from a mail subsidy. No mail subsidy that could be proposed would pay more than a small proportion of this extra cost; the greater part of it must come from passengers. What passengers have to pay for high speeds at sea may be seen by the rates charged in the fastest Atlantic steamers. Apart altogether from special cabins, or apartments de luxe, for which almost any prices are paid, the cost of a single first-class passage to New York varies from 22*l.* 10*s.* to 48*l.* 10*s.* for a run of six days, in one of the fastest liners, according to the position of the cabin in the ship and the time of year, or from 1¾*d.* to nearly 4*d.* per mile travelled. The prices have risen rapidly during recent years as speed has been increased, and passengers across the Atlantic appear to be forthcoming in ever-increasing numbers who are ready to pay them. If that were not the case such high speeds could never have been reached. No great improvement of speed is to be looked for upon the other main lines of ocean traffic, unless some revolutionary change is made in the mode of propulsion which will cut down the cost, or a sufficient number of passengers are found, as in the Atlantic trade, who will pay the higher rates it necessitates.

I have not done anything this evening towards reducing the number of the many and difficult unsolved problems that trouble the mind and tax the skill and judgment of the ship-designer, but if I have succeeded in conveying some idea to you of their nature, and of the interdependence of science and engineering in all wise attempts at their solution, I shall have accomplished my object.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LIVERPOOL.—Mr. J. Mercer has been appointed assistant lecturer in mathematics and Mr. T. E. Gardner assistant lecturer in organic chemistry.

A lectureship in plant physiology has been established in the botanical department through the generosity of Mr. W. P. Hartley (the donor of the laboratories).

Prof. Ronald Ross has been granted leave of absence for five months to enable him to report on measures for the prevention of malaria in Mauritius for the Colonial Office.

Prof. A. W. Mayo Robson will deliver the Mitchell Banks Memorial Lecture during the session 1907–8.

At the graduation ceremony held in St. George's Hall on July 13, *ex officio* degrees were conferred on several members of the staff, including Emeritus Prof. Paul, Dr. E. A. Browne, Prof. Watkinson, Mr. J. Wemyss Anderson, Associate Profs. Aspinall, Brodie, and Bromley Holmes. The dean of the faculty of science (Prof. Harvey-Gibson) presented the following for the degree of Doctor of Science, *honoris causa*, viz.:—Prof. A. R. Forsyth, Prof. F. Gotch, Sir Oliver Lodge, Sir Henry Roscoe, Sir William Ramsay, Sir John Murray, Prof. Ostwald, Prof. Osler, and (*in absentia*) Dr. C. L. A. Laveran. Sir Alexander Kennedy was presented for the degree of Doctor of Engineering by Prof. Watkinson.

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MR. ADAM SEDGWICK, F.R.S., has been elected professor of zoology and comparative anatomy in the University of Cambridge in succession to the late Prof. Newton.

SIR DOUGLAS FOX will deliver the inaugural address of a nature-study course for women, to be held at the Horticultural College, Swanley, from Saturday, July 27, to Saturday, August 10.

THE council of the City and Guilds of London Institute has conferred the fellowship of the institute upon Mr. Alfred E. Young, chief surveyor of the Federated Malay States, for his original and valuable work in the trigonometrical survey of the Malay States.

THE annual meeting of the Midland Agricultural and Dairy College will be held on Monday, July 29, at 3.15 p.m., when the report on the year's work will be presented. Sir John Rolleston will address the meeting and present the certificates gained during last session.

AT Bedford College for Women (University of London) the following courses, open free to teachers in secondary and elementary schools in the county of London, will be given in the Michaelmas term:—"Geology for Teachers of Physical Geography," by Dr. C. A. Raisin, beginning Wednesday, October 9, 6 p.m.; "The Organisation of Nature-study Courses in London Schools," by Miss M. R. N. Holmer, beginning Saturday, October 5, 10.30 a.m. Syllabuses of the lectures can be obtained on application to the principal.

THE East London College, which has gradually been evolved from the educational work connected with the "People's Palace," has been accorded the position of a school of the University of London by the Senate of that body. It has long been felt that there should be a school of the University in the eastern half of London; and for this position the East London College is admirably suited. The chemical department, under the charge of Dr. J. T. Hewitt, has done valuable work. Prof. C. H. Lees, F.R.S., was recently appointed head of the physics department, and the laboratories have been re-equipped and extended, while large grants have been made for the mechanical and electrical engineering departments by the Drapers' Company. Much research work has been accomplished under the professor of electrical engineering, Prof. J. T. Morris, and mathematics is showing signs of considerable development at the college.

THE need of reform at Oxford is urged in a letter signed by leading advocates of progressive learning in Wednesday's *Times*. It is pointed out that many members of the University are of the opinion:—(1) That the constitution and machinery of Oxford, both legislative and executive, need revision; (2) that the relations between the University and its colleges, both constitutional and financial, require modification; (3) that a central direction of our studies is required enabling the faculties to have the authority assigned to them in other seats of learning; (4) that the studies of the University are themselves too narrow in scope and that fresh endowments of various branches of study are necessary, and especially that a greater encouragement should be given to research, which at Oxford is probably to a larger extent divorced from teaching than in any other great university. As attempts at reform have again and again proved abortive, the signatories consider that either a fresh commission, or, if that suffices, legislation by the King in Council, as contemplated by the last commission, are the only practical ways of carrying out the necessary changes.

"THE influence of a body of thoroughly competent, zealous, and conscientious teachers in our public elementary schools may plainly be an important factor in our national life," says Sir Robert Morant in his prefatory memorandum to the new regulations (Cd. 3597) for the training of teachers and for the examination of students in training colleges. The general spirit of the regulations is likely to encourage work which will produce teachers of the right kind. The time for training is at best short, and it is important that the essential needs of the future teacher should receive primary consideration; the Board rightly warns college authorities against undertaking any too ambitious scheme. Where a university course of work is permitted to a student training to become an elementary-school teacher, the regulations insist that it shall not be at the sacrifice of some fundamental study or of facilities for obtaining practice in the art of teaching. Following the regulations of previous years, the necessity for inculcating the scientific method in the teaching of all subjects, and not confining such attempts to the instruction in science, is insisted upon. The memorandum admirably urges also that:—"The study of natural objects . . . should be so conducted as to encourage accurate observation and the careful recording of what is seen, with a view to the growth of an independent habit of thought, and the furnishing of a well-defined field of knowledge derived from immediate observation by the scholar." The necessity for lessons in elementary schools designed to familiarise children with the chief laws of health is now recognised by everyone, and great importance is to be attached by the Board to the education in this subject received by the student in training. The regulations as a whole will be read with satisfaction by all who have at heart the educational welfare of elementary-school children.

IN the third of the annual Harvard lectures, delivered at Yale University last April, Prof. A. Lawrence Lowell, the lecturer for the year, dealt with the subject of American universities. These lectures are the outcome of a fund provided by an anonymous Harvard graduate. In his lecture, which is published in *Science* for June 28, Prof. Lowell raises many points of wide interest. After directing attention to the value to civilisation of the great European universities at the close of the Middle Ages, he said that American universities are not only growing larger, but their influence is extending more widely through the body politic. In addition to being training places for young men, the universities in the States aim at diffusing learning directly or indirectly through all strata of society, helping to bring light to anyone who wants it. It is being more fully understood, too, that a university should not be merely a local institution, but one bringing together students from all parts of the country. As Prof. Lowell remarked, "should a general custom arise for every man to attend exclusively the university in his own neighbourhood, it would be a great misfortune to education in America." Referring to the two classes of universities in the United States, Prof. Lowell instituted an interesting comparison between State universities and those not supported by taxation. He comes to a similar conclusion to that arrived at by President Pritchett in the first bulletin of the Carnegie Foundation, that the most vigorous of the State universities have been, as a rule, those which have thrown themselves most completely upon the State and obtained the smallest fraction of their support from private benefaction. We commend this experience to British statesmen in the hope that American experience of

the great value to the community of universities endowed from State funds may lead them to emulate American practice in this respect.

THE regulations for secondary schools (Cd. 3592) issued by the Board of Education, to come into force on August 1, mark a distinct advance in educational administration. More elasticity is to be allowed in the Board's dealings with secondary schools; more encouragement is to be given to local initiative and local effort; and certain defective features in older regulations are removed. The additional funds now available for secondary education have made it possible to abolish the limited four years' course on which alone grants have been paid hitherto. A uniform grant will in future be paid on pupils between twelve and eighteen years of age who are following an approved curriculum, and, what is of prime importance from the point of view of the schoolmaster, the term instead of the year is to be taken as the unit in assessing grants. The subjects to be studied and the time to be devoted to each has in the past been prescribed by the Board; for the future the head teacher and local authorities are to be encouraged to submit to the inspector for approval courses of work designed precisely to suit local needs and conditions. In the payment of grants it is interesting to note that the Board is prepared in certain cases to augment the grant due to a school by a further sum towards meeting expense incurred by the school in respect of approved educational experiments. There is ground for hope that this arrangement may hasten the methodical building up of a science of education. This adoption of the plan followed in all other scientific work of basing conclusions upon experiment and observation should lead to many improvements, and it is to be hoped that much thought and the best talent will be devoted to the inauguration of the age of scientifically arranged experiments in education. The regulations will, if sympathetically and intelligently interpreted, greatly improve English secondary education.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, June 6.—"The Mechanical Effects of Canal Rays." By A. A. Campbell **Swinton.** Communicated by Sir William Crookes, F.R.S.

This investigation was undertaken in order to discover whether the so-called canal rays, which at suitable pressures can be seen streaming through the apertures in a perforated kathode, backward away from the anode, share with kathode rays the property of causing small and light mill-wheels to rotate.

Experiments were conducted with tubes in which there were a number of perforations in the kathode, so that the canal rays, after passing through these, impinged on the vanes of a mill-wheel of screw-propeller form, and also with other tubes in which there was only a single perforation in the kathode, and the canal rays acted on the vanes of a mill-wheel of water-wheel type. In both these forms of tubes mill-wheels with vanes of mica, as also with vanes of aluminium, were employed, and in every case rapid rotation of the mill-wheel occurred at suitable pressures in the direction corresponding with that of the canal rays. That this was due to the canal rays was proved by closing the apertures in the kathodes by means of aluminium shutters, when rotation could not be produced, as also by subjecting the tube to a powerful magnetic field so as to deflect to one side all direct or reflected kathode rays.

Experiments were also made with screw-propeller mill-wheels mounted in front of the kathode. In this case, when the vanes of the mill-wheel were of mica, the rotation obtained always corresponded with the result being due to bombardment by kathode rays proceeding away from the kathode; whereas, when the vanes were of aluminium, rotation in the contrary direction invariably took place, this corresponding with the effect being due to canal rays proceeding towards the kathode.

It was further ascertained by means of two thermo-junctions of Constantan copper—one on each side of a mica vane, arranged so as to oppose their E.M.F.'s, and connected to a mirror galvanometer—that under canal-ray bombardment the two sides of a mica vane may acquire differences of temperature amounting to as much as 200° F. It is suggested that the heat insulating properties of mica and the high thermal conductivity of aluminium have probably an important bearing on the divergent results obtained with these two materials, as mentioned above.

**Physical Society**, June 28.—Prof. W. E. Ayrton, F.R.S., past-president, in the chair.—Experiments on the production of sand ripples on the sea shore: Mrs. **Ayrton.** The sand-ripples of the sea-shore, although parallel to the line of the breakers, are not produced by their edges, but entirely under water. The long see-saw motion of the water produces the ripples, as was observed in 1882 by Mr. A. Hunt. To show this, a glass trough, in which was level sand, covered with a foot of water, was pushed to and fro on rollers. This motion set the water oscillating, and soon small ridges were seen in the sand, at nearly equal distances from one another, growing larger as the oscillation continued. By deduction from the shape of certain sand vortices, it appears that every ridge in otherwise smooth sand must produce two other ridges, one on either side of the first, and that these two give rise to two other ripples, until the whole becomes ripple-marked. Experiments were shown to demonstrate this fact. To show that the vortices generated by the original ripple swept out those succeeding, an artificial barrier was put across the trough to increase the size of the vortices, a handful of moist black pepper was thrown in, and the water oscillated. Immediately the actual process by which the water started and built up the ripples was shown. The way was illustrated in which the ripples on the sea-shore could be imitated, even when the water ran in one direction alone, if only the sand were sloped so that the water ran up it, and if, by means of a paddle, a series of waves were sent along the water in the direction in which it was running. The whole of the sandy shore is ripple-marked when the tide is high, but the waves at the edge of the retreating tide wipe out the ripples except where there is a pool, so that the water is left over the ripples until after the sea has retired. The greatest depth at which ripple-mark can be formed at the bottom of the sea depends on the violence of the motion of the water. At depths of 60 feet or 70 feet the sand is said to have been found ripple-marked. If the depth of a vessel is large compared with its cross-section, a depth of water can be found beneath which no sand-ripples can be formed. On sprinkling a little sand in the water in a small trough, and rocking it to and fro, the sand was seen to assemble quickly in a straight line across its middle. Watching these grains, it was noticed that the result arose from every swing carrying each grain on one side of the centre nearer to the middle than the next swing carried it away again. Each ripple as a whole tends to move towards the middle of the trough. In troughs, the water was kept oscillating so as to form a stationary wave twice the length of the trough, and the place where the heap of sand was formed was where the level of the water changed least, and its horizontal velocity was the greatest. Referring to the Goodwin Sands, Mrs. Ayrton said she found it impossible to avoid recognising the resemblance between the hillocks and hollows of these sands and those made in her glass troughs, and it seemed possible that they were also produced by stationary waves.

### CAMBRIDGE.

**Philosophical Society**, May 20.—Dr. Hobson, president, in the chair.—Exhibition of photomicrographs of wood-sections made by Mr. J. A. Weale: E. R. **Burdon.** —Parasitic trees of southern India: C. A. **Barber.** The sandal tree, *Santalum album*, was discussed; although a large tree with abundant foliage and thick stem, it is dependent for its water and mineral salts on the roots of other plants. The disease called locally "spike" was illustrated by a series of lantern-slides. Four genera of Olacaceæ, Olax, Ximenia, Opilia, and Cansjera, large green climbers or shrubs, are now known to be parasitic like the sandal. The arrangement of the subgroups of the Olacaceæ has been unsatisfactory for a long time. The study of the haustoria endorses the arrangement proposed by Van Tieghem whereby the Opilieæ are transferred to near the Santalaceæ. Special attention was directed to the

presence of a complicated gland in the haustoria of *Santalum album* not hitherto described in any root-parasite. The gland is present in most, if not all, of the haustoria dealt with. Diagrams were shown of the haustoria of *Thesium Wightianum, Buckleya Quadriala* from Japan, *Osyris arborea, Cansjera Rheedii, Ximenia americana, Olax scandens*, and *Opilia amentacea*.—Physiology of plants in the tropics: A. M. **Smith.** (*a*) The internal temperature of leaves under tropical insolation. In still air, with black bulb vacuum thermometer at from 55° C. to 62° C., the air temperature in the shade being from 25° C. to 28° C., and the humidity about 70 per cent., leaves, whether thick and fleshy, or thinner and coriaceous, or thin and pliable, when placed normal to the sun's rays reach a temperature of 15° C. above that of the surrounding air, a temperature often considered injurious to the functions carried on in the leaf. In the shade the internal temperature varies from 1°·5 below to 4° above that of the surrounding air. Breezes reduced the temperature in the sun by amounts varying from 2° C. to 10° C. An attempt was made to estimate the magnitude cooling due to transpiration. Two leaves with stomata outwards were consistently lower in temperature than two with their stomatal surfaces facing each other. The difference was on an average 2°·5 C. Investigations into leaves with red or red-brown colouring matters showed that the red pigment raised the internal temperature of the leaf from 2° C. to 4° C. above that of similar leaves which were white or nearly so. (*b*) Periodicity of growth in Ceylon. Monthly observations showed that there was the largest amount of young growth in February, the driest month of the year. The theory is suggested that only then is there sufficient transpiration to supply the necessary mineral food for rapid growth. (*c*) Respiration of *Hydrilla verticillata*, a tropical water-weed. Values for the respiration from 7° C. to 50° C. were obtained. These when plotted produce a curve which shows increase of respiration with temperature according to the van 't Hoff rule, the coefficient for an increase of 10° C. being 2·2. The values go on increasing up to the death-point of the plant.—Notes on the parasitism of Botrytis: F. T. **Brooks.** The conidia of Botrytis are unable to infect healthy green leaves, whereas if a young mycelium, nourished saprophytically, is placed upon a normal leaf of such a plant as lettuce, infection rapidly spreads. Experiments have been undertaken to ascertain whether the conidia can cause the infection of weakened plants. Lettuce plants were grown in sterilised sand, watered from time to time with mineral solutions. After these plants had been growing six weeks the conidia had no power of infecting them. By tearing healthy green leaves of lettuce plants direct infection is caused by placing the spores upon the torn portion. The conidia are able also to infect leaves just beginning to turn yellow.—A representation of the exponential function as an infinite product: G. B. **Mathews.**—Some theorems on integral equations: H. **Bateman.**—The theory of the rotation of the plane of polarisation by solutions: Prof. **Thomson.**

EDINBURGH.

**Royal Society**, June 10.—Dr. Robert Munro, vice-president, in the chair.—A contribution to the craniology of the natives of Borneo, the Malays, the natives of Formosa, and the Tibetans: Sir William **Turner.** The paper contained a full discussion of the characters of the skulls of the various peoples and races inhabiting the regions named; and one fact of general significance was the prevalence of the dolichocephalic type in the people of the interior of Borneo, Sumatra, Formosa, and the Philippines, and in the inhabitants of eastern Tibet, while the brachycephalic skull was characteristic of the sea-board peoples.—The histology of the Ephedreæ, with special reference to the value of histology for systematic purposes: R. J. D. **Graham.** The primary structures of sixteen species or varieties were examined. The outer walls of the epidermal cells have a middle stratum containing crystals of calcium oxalate. Certain papillose epidermal cells act as ocelli, giving the light-spot and image described by Haberlandt for leaves. The cortex is differentiated into an outer palisade and inner lacunar chlorenchyma. The stereon system is built on a girder principle, the outer flanges of each girder hypodermal, the inner pericyclic. Tannin sacs occur in the pith and cortex. The stelar system resembles somewhat that of Equisetæ, but differs in each leaf having two bundles which extend through two stem internodes. The characters which the author regarded as of use in determining subgeneric groups and in distinguishing varieties were the stereon distribution and degree of development, the distribution of the tannin sacs, and partially the character of the stelar system taken at a given level (the second internode below the apical bud).—The variation of Young's modulus under an electric current: H. **Walker.** Wires of steel, iron, platinum, and copper were heated by an electric current of gradually increasing and decreasing strength, and corresponding measurements of Young's modulus made. In steel, iron, and copper there was a decrease in the modulus for weak currents, then an increase to a maximum as the current increased and the temperature rose, finally falling off again as higher temperatures were reached. The return for decreasing currents followed a somewhat similar course, but not coincident with the course of the change during the increasing current. In the case of platinum, there was no initial decrease of the modulus for weak currents.

June 17.—Prof. A. Gray, F.R.S., vice-president, in the chair.—At the request of the council, Baron **Kikuchi** gave an address on Japanese national development, more especially with reference to education. The main purpose of the address was to show that the Japanese national spirit, which consisted of intense love of country and reverence for the Imperial house, had remained intact through the long centuries of change and growth, largely influenced as these had been by Chinese literature and philosophy, Indian religion, and in later days by Western learning.

June 24.—Dr. R. H. Traquair, F.R.S., in the chair.—The evolution of the eyebrow region of the forehead, with special reference to the significance of its excessive development in the Neanderthal race: Prof. D. J. **Cunningham.** The usual types of supra-orbital arch in recent man are what are seen in the baboon. The Neanderthal type, which approximates to that of the anthropoid apes, is also to be found, but rarely in a highly developed state, in individual members of certain races such as the Aboriginal Australians and New Guineans, and the Maories. These facts, which have an important bearing on Schwalbe's recent theories, were fully demonstrated from specimens by means of ordinary photographs and Röntgen-ray photographs.—The origin of the amniotic and allantoic fluids: Prof. D. Noel **Paton** and Dr. B. P. **Watson.** Anatomical, pathological, and experimental evidence was brought forward in support of the view that both fluids are derived from the fœtus and not from the maternal blood vessels, and as a result of an extensive series of chemical examination of the fluids it was concluded that they are both derived from the fœtal kidneys.—The application of a differential densimeter to the study of some Mediterranean waters: J. J. **Manley.** The instrument is an adaptation of Hare's hydrostatic method for comparing the densities of two liquids, and was found to be capable of great accuracy. A series of results showed the effects of variation of temperature upon the relative densities of normal sea water.—The electric conductivity and angles of minimum deviation of ninety samples of sea water, and a comparison of these with the salinity and density: Prof. E. G. **Hill.** The purpose of the comparison was to see if these physical properties could be used for measuring the salinity and density. The conclusion was that, though the physical properties were not exact measures of the chlorine in sea waters, the differences between the values for chlorine calculated from the physical constants and that measured by titration were so small that for purposes of oceanography it may be assumed that the values are identical.

July 2.—Prof. Crum Brown, F.R.S., in the chair.—Address on the work at the solar observatory, Kodaikánal, S. India: Prof. C. Michie **Smith.** The address began with a discussion of the conditions which must be fulfilled by a good solar observatory, and of the practical difficulties in the way of realising these conditions. Kodaikánal, from its steady climatic conditions and its elevation, was probably on the whole as well fitted for this kind of work as any other single observatory. In some years there was

sunshine for 346 days out of the year. The general arrangements of the observatory were described, but especially the methods for conducting solar research. A series of spectroheliograms showing the distribution of calcium vapour in the sun's atmosphere was exhibited; also photographs of the sun's disc and of the marginal prominences. Some interesting questions were touched upon as to the interpretation of certain markings in the spectroheliograms.

DUBLIN.

**Royal Dublin Society**, June 18.—Dr. J. H Pollok in the chair.—Injurious insects and other animals observed in Ireland during the year 1906: Prof. G. H. **Carpenter.** In addition to records of well-known orchard and forest pests, this paper gives an account of damage to barley by maggots of the small fly *Elachyptera cornuta*, and to young cabbage plants by grubs of the beetle *Psylliodes chrysocephala*.—The densities and specific heats of some alloys of iron: W. **Brown.** The author has investigated the change in the densities and specific heats of about fifty different specimens of iron alloyed with various percentages of carbon, manganese, nickel, tungsten, silicon, copper, chromium, cobalt, and aluminium. The more important results are graphed, and the effect of adding 1 per cent. of an element to iron estimated.—A simple and rapid method of determining the rate of absorption of oxygen by polluted waters: Dr. W. E. **Adeney.**

PARIS.

**Academy of Sciences**, July 16.—M. A. Chauveau in the chair.—The structural stability of ethylene oxide: Louis **Henry.**—How far it is possible to justify the use of the arithmetic mean in calculations on the results of observations: Giovanni **Schiaparelli.**—A report on the scientific mission to the gardens and public zoological establishments of the United Kingdom, Belgium, and Holland: Gustave **Loisel.**—The method of M. Loewy for the study of divided circles: MM. **Gonnessiat** and **Drayet.** Results show that it would be a mistake to limit the use of the division to entire degrees, leaving the remainder to a simple interpretation; this would involve, even in the mean of six microscope readings, errors of more than 0″·2.—The surfaces generated by a circular helix: M. **Barré.**—Remarks on the theorem of Jensen: C. **Carathéodory** and L. **Féjer.**—A fundamental problem in the theory of elasticity: A. **Korn.**—The difference of potential in an arc running continuously between metallic electrodes: C. E. **Guye** and L. **Zébrikoff.**—The influence of pressure on the absorption spectra of gases: A. **Dufour.** Some rays remain of the same wave-length under increased pressure; others are displaced in the spectrum towards the red, according as the pressure is increased. All sensible rays under pressure show the Zeeman effect to a very feeble extent.—Synchronising in multiple reflections: Henri **Abraham.**—The valency of the molecule in salt solutions deduced from the dispersive properties of the solution and the theory of electrons: C. **Chéneveau.**—The origin of series spectra: W. **Ritz.**—The scale of molecular weights of gases: Daniel **Berthelot.** The table of molecular weights defined by the densities of gases only represents a system of numbers, and must be fixed by relation to a gas of reference.—Some new characteristic constants of oils: E. **Louise** and E. **Sauvage.** Observation of the miscibility with acetone gives rapid determining characteristics for many oils.—The hydrolysis of iron perchloride: G. **Malfitano** and L. **Michel.** It is probable that the hypothetical products $FeCl_2(OH)$ and $FeCl(OH)_2$ exist, while $Fe(OH)_3$ can only exist temporarily in solution.—The production of high temperatures in laboratory research: C. **Chabrié.**—The analysis of selenium hexafluoride: Paul **Lebeau.**—Ethyl hexahydrobenzoylacetate: A. **Wahl** and A. **Meyer.**—The action of diazo-chlorides on γ-chloro-aceto-acetic esters: G. **Favrel.**—Triphenylcarbinol. The action of malonic and cyanacetic acids: R. **Fosse.**—The oxidation of oxyhæmoglobin: I. **Szreter.**—A contribution to the study of the brandies of Charentes: E. **Kayser** and A. **Demolon.**—The neo-volcanic formations anterior to the Miocene in the north-west of Sardaigne: M. **Deprat.** The first eruptions were characterised by the emission of rhyolites, but the greater part of the region is marked by the presence of the less acid trachytes and andesites.—An investigation on the foreign fats in lard: Alexandre **Leys.** The fraudulent addition of oil to genuine lard only changes the melting point, without reducing the specific gravity.—The separation of odorous principles in plants: Eug. **Charabot** and G. **Laloue.**—Some new observations on the Carboniferous earths of the Sahara: G. B. M. **Flamand.**—Some experiments made with radium bromide: A. **Jost.**

NEW SOUTH WALES.

**Royal Society**, May 1.—Prof. T. P. Anderson Stuart, president, in the chair.—Presidential address: Prof. T. P. Anderson **Stuart.** The address reviewed matters chiefly connected with medical questions. The true value of the Danysz rabbit experiments was set out, showing that, even if successful to the fullest possible extent, this method of coping with the pest could never be more than auxiliary to the methods already known and in use. The Danysz rat-virus, and its complete failure under the most favourable conditions, in New South Wales, was next described, and the question asked—if this virus has been such a failure, what grounds have we for expecting a better result with the rabbit-virus? The bubonic plague was referred to in connection with the recent report of the Indian Plague Commission, and the apathy of the people in Sydney as regards the destruction of rats was condemned. In connection with the death of Schaudinn, the discoverer of the *Spirochaeta pallida*, the long-sought virus of syphilis, the most successful experience of an entirely free and unrestricted treatment of female patients suffering from contagious diseases in Sydney was described. Reference was now made to the opsonin treatment, and to its introduction in Sydney at the Royal Prince Alfred Hospital. The movement for establishing a school of tropical medicine in Australia was fully discussed and commended.

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