THURSDAY, MARCH 16, 1893.

MACPHERSON'S FAUNA OF LAKELAND.

A Vertebrate Fauna of Lakeland, including Cumberland and Westmoreland, with Lancashire North of the Sands. By the Rev. H. A. Macpherson, M.A., with a Preface by R. S. Ferguson, F.S.A. (Edinburgh: D. Douglas, 1892.)

INTRODUCED to the vocabulary of naturalists by Mr. H. Cottrell Watson, more than fifty years ago, and that in the most prosaic way, the word "Lakes," as the name of an English district, still keeps its poetic fragrance, which is perhaps even intensified by its modern modification into "Lakeland," notwithstanding the very technical prefix, as in the title of this book, of "A Vertebrate Fauna." One is naturally led to think of that school of versifiers whose early efforts excited so many conflicting feelings when the century was young, but whose later lays have at length brought conviction of their worthiness to the minds of most. One of their company, he who furnishes the motto of this journal, has especially been hailed as *the* Poet of Nature, and not only does the fame of Wordsworth wax yearly, but there are those who greet every line he wrote with adulation. To such admirers the author of the book before us will seem to have missed his opportunity, in that we fail to find in the whole volume any indication of the penultimate Poet Laureate having ever belonged to the "Vertebrate Fauna of Lakeland." Does this signify that naturalists are not poetical or that the great "Poet of Nature" was not a naturalist? The question is so momentous that we leave it for consideration by our readers, not daring to vouchsafe a reply, nor venturing to suggest to Mr. Macpherson that he has been wrong in resisting the temptation to illustrate his work by quotations, that might be gathered by the handful from the thousands of verses which flowed from the pen of the "bard of Rydal," or any of his brethren.

We must acknowledge that we took up this volume with a slight prepossession against it. We did not see why Mr. Macpherson, already the joint author of a well-known and well-esteemed little book on the "Birds of Cumberland," to say nothing of various contributions to Natural History journals, should need a preface for his new work by a gentleman who—whatever may be his legal and antiquarian renown (which we believe to be not small)—is entirely unknown as a naturalist, and it seemed to us as though a kind of sub-episcopal *imprimatur*, which would be derogatory to a man of science, had been sought from the Chancellor of the diocese of Carlisle. We have been glad to find this suspicion, perhaps ill-natured in its inception, wholly unfounded as we became acquainted with the contents, and we hereby make confession of our error, duly cautioning all others, and there may be a good many of them to whom the same thought may occur or have occurred, that any such hesitation is unnecessary. The Preface, it is true, contains a benediction, but none can say it is a benediction that is undeserved. The book is a real honest book, and one that no true zoologist can fail to discover has been wrought at with conscientious care, unbounded labour, and a deep sympathy with the subject. We are not going to hold it up as a model "Fauna"; there is evidence, notwithstanding what we have just said, of too much haste in its composition for that; but it certainly belongs to the first class of books of its kind, while, should it be the author's good fortune to have another edition demanded, a severe revision might give it a high place in that class. We do not assume ourselves to be purists in style, but it does seem to us that the English language, as written by men of acknowledged literary merit, is wide enough to cover every shade of meaning, without the least necessity of bringing in words or phrases that border upon slang, and certainly without using slipshod expressions that, if not altogether inappropriate, are in many cases vague and therefore unseemly in a book that may fairly claim to rank among scientific works. We assure the author in all good will that these shortcomings, which might be so easily remedied, greatly diminish the pleasure we derive from reading his volume.

Apart from Mr. Ferguson's scholarly Preface, the book opens with more than one hundred pages of Prolegomena, and we are mistaken if the greater part of these will not prove to have greater interest for that incomprehensible person the General Reader than all that follow—the particulars given in the bulk of the volume being mostly of especial and local value. Not that we use this last epithet in any invidious sense, for what should a local Fauna be but local? and Mr. Macpherson has avoided a great error (into which the authors of some modern local Faunas have fallen), by rightly taking it for granted that the zoological readers who will use his book do not want to be instructed on points or matters concerning which they can obtain full information from many other and more original sources, and thus he is able to husband his space for particular details, which are given in most cases with great precision. But first of these Prolegomena aforesaid—They begin, as every book of this sort ought, with what is practically a history of the subject; for it is a biographical notice of former Lakelandish worthies who have contributed to the Vertebrate Zoology of their district, and of these there is a good show; though there is no wonder that the earliest writers on the subject should possess but little scientific knowledge. It is not every county that can produce a Willughby, a Sir Thomas Browne, or still less a John Ray—but probably the earliest of the naturalists celebrated by Mr. Macpherson were the equals of Charleton, Plot, or Leigh—all men worthy to be praised in their own line. Yet setting aside these lesser lights, many of whom are lost to view in the glare that radiates from their successors, the two Heyshams (John, born 1753, died 1834, and Thomas Coulthard, born 1791, died 1857), and the two Goughs (John and Thomas, whose joint lives cover all but a century and a quarter, 1757–1880)—in each case father and son—were men deserving commemoration in any county, and the biographical notice of all four, written in excellent taste, will be gladly read by many who are not naturalists at all. For our own part we cannot help wishing that these biographical details had been longer; but the papers of the elder Heysham are not forthcoming, neither is the manuscript Cumberland Ornithology, which the younger is supposed to have left at his death. The former, if still

existing, would no doubt throw much light on more than fifty years of Cumbrian Natural History; but most likely everything of value in the latter was communicated to Bell or Yarrell, with whom its author was in frequent correspondence, and during his later years he led a life of seclusion. The elder Gough was an extraordinary instance of a naturalist successfully pursuing his vocation under a grave difficulty, for the like of which we can only call to mind Huber and M. Van Wickevoort-Crommelin, since at an early age he became blind from small-pox, and if he was thereby disabled from advancing investigation according to his bent, it did not hinder him from training his son to follow his footsteps and indoctrinating him with so wide an attachment to science that he became an intimate friend and correspondent of Sedgwick the geologist and of Cornelius Nicholson the antiquary, establishing with the latter's aid the Kendal Literary and Scientific Institution. The pious duty of celebrating his predecessors' obsequies being performed, Mr. Macpherson next turns to other extinct mammals of Lakeland, and his researches respecting the Wolf (an entire skeleton of which, found in a cave by Mr. John Beecham, is preserved in the museum at Kendal) and the Wild Boar have been rewarded by the discovery of documentary evidence not without interest, even if it does not add much that is of value to our information concerning these ancient beasts. We have too some facts in relation to the Red Deer and the Wild Ox, though more is said of them, and some of it is of importance, in the body of the work (pp. 50–76), and we do not see why the former at least of them should be called extinct, seeing that though greatly restricted in range it still exists in freedom, while the latter, whose right German name Mr. Macpherson persistently curtails, misspelling it "Auroch" for *Aurochs*, was undoubtedly the ancestor of the white breed, of which the last herd in the district, having been emparked at Thornthwaite near Haweswater, was removed in or soon after 1630 to Naworth, and by 1675 had ceased to exist. A chapter devoted to "The Destruction of Wild Animals" will be instructive reading to many people. It contains what will be a revelation to those who can appreciate the facts of "how not to do it." Our excellent forefathers (and many of their descendants are not much wiser) knew very little of the way in which wild beasts could be extirpated, and consequently the warfare against them lasted for centuries. Some few, still accounted enemies of the human race, yet defy their persecutors; but the greater number have perished, and in the present depleted state of the Mammalian Fauna of the British Islands, it would be inexpedient to point out how the extinction, at least in parts, of some two or three species might be accomplished in perhaps twice as many years. The average gamekeeper (fortunately or not) has very little knowledge of zoology, and the average master even less. On this particular we have no wish to enlighten either, so we shall preserve a silence that all animals' friends will admit to be golden. But we must always remember that by far the most destructive four-footed "vermin" of our day is religiously and rigorously preserved by a general sentiment, so much stronger than any law, in a way that would have caused to wonder those who "kenned John Peel" and his forefathers. In favour of Mr Macpherson's next treatise on the Variation of colour in Animals not much is to be said, and this *capitulum* will disappoint most who consult it, while we take leave to observe that though many authorities are cited from the *Carlisle Patriot* of these times to Dr. Caius of 1570, that learned man assuredly never wrote a book with a title so tautological as "*De rariorum animalium et avium stirpibus*," which must have been taken (p. lxxvi, note) at second hand from one of the popular writers, who imagine that birds are not animals and do not know the technical meaning of *stirpes*. Albinescent specimens if not albinos have, it is well known, a great charm for some collectors—why, scarcely any reasonable being can say—and it is of them that our author chiefly discourses (using too a word—"leucotism"—quite unfamiliar, but apparently meaning the same as the recognised "albinism") though so far as we know little scientific interest attaches to them; but we do not quite see the point of his remarks (p. lxxviii) on "the tendency in the direction of variation" of the Lakeland Viper. He only mentions two examples, and what are they among so many? Nevertheless the one figured is strange-looking enough, and it would have been satisfactory to be assured that there can be no mistake in the determination of the species. The succeeding chapter is devoted to Hybrid Birds; but here again we find not much of interest in a general way on that little-known and extremely interesting, not to say important, subject. Mr. Macpherson has been so fortunate as to see more than one wild hybrid between the two British species of Sparrow (*Passer domesticus* and *P. montanus*) and considering that these are species in what some would call the "physiological" sense—the sexes being outwardly alike in the latter and wholly different in the former—the question deserved further attention than is bestowed upon it (pp. lxxx—lxxxi).

More instructive is what follows on "Bird Fowling" (as the author redundantly terms it) or rather we should say more instructive it might be. There is mention (p. lxxxviii) of the netting of Razorbills and Guillemots on the rocks of St. Bees', taken, we are told, from the "Sandford MS. p. 18," but where this manuscript is to be seen or of what age it may be we are not told, and the language of the passage quoted only shows that it is not exactly of yesterday. Now the netting of *Alcidæ* is not, so far as we are aware, known to have been practised elsewhere in Britain, and Mr. Macpherson says the custom is obsolete in Cumberland, probably from there not being birds enough left to make its continuance worth the while of the "Hivites," for it may be accepted as a universal rule that the taking of birds at their breeding haunts year after year, unless under such conditions as St. Kilda presents, must end in their diminution and may easily be carried on to their extinction.

For the rest of the Prolegomena there is no need to say anything, and we willingly pass over the useless representation (p. xcvi) of the Polish Swan's trachea, though we congratulate Mr. Macpherson on being able to figure (p. ciii) the foot of a real Westmorland Sea-Eagle, not a mere "marauder from over the border"—as most of the examples killed in England are—but a mournful relic for all that.

Into the details of Lakeland species we shall not attempt to enter. To criticise that portion of the volume

the critic should have nearly as much local knowledge as the author, and we pretend to none. To some though not to a great extent the besetting sin of nearly all "Faunists" is evident, and that is the tendency to exalt the importance of the capture of stray individuals, this especially among birds. The occurrence of these wanderers is undoubtedly worth recording; but that a zoologist should claim consideration for Cumberland because a *Saxicola isabellina* was shot there, or for Furness because a *Pelagodroma marina* was washed up on Walney, is an indication that he takes rather a narrow view of things—though we are bound to admit that Mr. Macpherson at the same time descants on the merits of the Wheatear as a characteristic Lakeland bird; and, especially as befits one by descent "servile to *Skyey* influences", laments the almost complete absence from the Lakeland seas of the Manx Puffin, due no doubt to its extirpation in the neighbouring island, or its Calf, that gives it an English epithet nowadays inappropriate. Indeed there is no fault to find with our author in his sympathy for the *true* denizens of his district, and the highest praise is due to him for the labour he has exercised, of which almost every page bears witness, in telling their story. To wind up we must add, what perhaps we ought to have said before, that for the purpose of this work "Lakeland" consists of the counties of Cumberland and Westmorland, together with that part of Lancashire known as Lancashire Over-Sands, being identical, the Isle of Man excepted, with the "twelfth Province" of Mr. Watson's *Cybele Britannica*; but the want of a map of the entire district is a grievous drawback, for which even the dozen or more excellent etchings, showing as many places of interest, do not wholly make amends.

THE EVOLUTION OF DOUBLE STARS.

Die Entwickelung der Doppelstern-Systeme. Von T. J. J. See. 60 pp. (Berlin: R. Friedländer und Sohn, 1893.)

THE essay which we review is a dissertation for the doctorate of philosophy of Berlin, and the author, Mr. See, is an American, although he writes in German.

The component stars in double systems appear to be usually of comparable magnitudes, and are found to move in highly eccentric orbits. This case the author holds to be the normal one, whilst the solar system, with its one preponderant mass, and its nearly circular orbits, would be exceptional.

He attributes the observed high eccentricity of orbit to the influence of tidal friction, and accordingly the greater part of the paper is devoted to the consideration of the results which will ensue from the supposition that each of two bodies raises in the other tidal disturbances, which are subject to frictional resistance.

If the rotations of the two bodies differ in speed, the problem is an insoluble one, without some postulate as to the law of the frictional resistance. The author is, however, of opinion that sufficient insight may be gained from the solution in the case where two equal bodies rotate with equal speed. This opinion seems justifiable, but it might have been well if the dynamical stability of equality of rotations had been explicitly pointed out. That there is such stability is clear from the consideration that, if one of the bodies rotates more rapidly than the other, it is subjected to a more rapid retardation of rotation, and there is accordingly a tendency towards the restoration of equality.

The influence of tidal friction on the elements of the orbit of a satellite and on the rotation and obliquity of a planet have been investigated in my several papers, and Mr. See here adapts my conclusions to the case of the double tidal friction of two stars. The adaptation is not difficult, for whilst the rate of change in the rotation of each star remains the same as though the other did not rotate, the rates of change of the elements of the orbit are exactly doubled. Mr. See has then redrawn the curves which exhibit the gradual transformation of the system, and, as might have been expected, finds them to have features closely similar to those of my curves.

The generality of these solutions is limited by the supposed smallness of the eccentricity and of the inclinations of the orbit and of the two equators to the plane of reference. The author, however, then passes to a second case, which is more special in that the equators of the stars remain coincident with the plane of the orbit, but which is more general in that the eccentricity is not treated as being necessarily small. The object is to obtain a numerical solution of the following problem:—Two equal stars, each of three times the sun's mass, revolve in a nearly circular orbit at a distance equal to that of Neptune from the sun, and the rotation of each star is nearly equal to its orbital motion; it is required to find the greatest mean distance and the greatest eccentricity of orbit to which the system will change under the influence of tidal friction.

Mr. See solves this problem by methods analogous to those which I have employed, and finds that the mean distance will increase from 30 (Neptune's distance) to 50, and that the eccentricity will increase from an assumed initial value of one-tenth to a maximum of about three-fifths, which is attained a little earlier than the maximum of mean distance.

It may be remarked that these results can only be very rough approximations to the truth, because the calculation is conducted on the supposition that the moment of inertia of each star is the same as that of a homogeneous sphere of the same mass and radius, whereas it is obvious that the stars would really be highly condensed spheroids of great oblateness.

It is to be regretted that the calculation has not been repeated with variations of the assumed initial conditions. It is easy to see that a change in the assumed degree of concentration of the stars would give very different results. Supposing, for example, the stars had had only half the diameter assumed, the rotational moment of momentum would have had a quarter of its value in Mr. See's example. Now the enlargement of orbit is due to the transference of rotational to orbital moment of momentum, and thus the transferable moment of momentum would only have amounted to one quarter of its former value. But the orbital moment of momentum varies as the square root of the mean distance, and hence the enlargement of the orbit could not have been so much as one-sixteenth of its former value. We may feel sure that

the increase in the eccentricity of orbit would also have been largely reduced.

Notwithstanding this criticism, it appears to me that Mr. See fairly establishes the proposition that a high eccentricity is explicable by means of tidal friction.

Turning, then, to the question of the relative masses of the components of double star systems, Mr. See remarks with justice that the comparable brightness of the components renders it highly probable that the masses are also comparable, and he sees in certain results of M. Poincaré and of my own an evolutionary explanation of this fact.

Jacobi first showed than an ellipsoid of homogeneous fluid, with its three axes bearing to one another proper proportions, is a figure of equilibrium when it rotates about its smallest axis with a proper angular velocity. M. Poincaré next showed that if the length of the Jacobian ellipsoid exceeds the breadth in a certain ratio, the equilibrium becomes unstable, but that there is a stable figure which may be described as a Jacobian ellipsoid with a furrow nearly round the middle, so that it resembles an hour-glass with unequal bulbs. If we trace the further development of the hour-glass we find its neck gradually thinning, and finally rupturing the figure of equilibrium, henceforth consists of two detached masses.

My own attack on this problem was from the opposite point of view, for I endeavoured to trace the coalescence of a pair of detached masses so as to form an hour-glass or dumb-bell.

Mr. See reproduces the figures illustrative of both these investigations, and remarks that they both show that when there is a gradual detachment from a rotating figure of equilibrium, the detached portion will not normally be a ring, but that there will ensue two quasi-spheroidal masses of matter of comparable magnitude. He also remarks that if the fluid be heterogeneous, the ratio of the masses will be much smaller than when it is homogeneous.

In the discussion of these figures of equilibrium the wording of the essay appears a little careless, for it might naturally be supposed to mean that increase of angular velocity is a necessary concomitant of the rupture of the neck of the hour-glass. Now it is a somewhat paradoxical fact that, with constant density, the longer elongated figures of equilibrium rotate more slowly than the shorter ones, and it might therefore seem that the rupture of the neck should go with retardation of angular velocity. But it is the value of the square of the angular velocity divided by the density which determines the length of the elongated figures, and thus increase of density tells in the same way as retardation of angular velocity. In the history of a nebula the only condition for rupture which can be specified is that of contraction.

The probability of this view of the genesis of double stars is strikingly illustrated by a number of drawings by Sir John Herschel of various nebulæ. The great similarity between Herschel's nebulæ and the theoretical hour-glass is obvious. It may be hoped that in the book which Mr. See promises he will also illustrate this point by photographs.

Annulation is usually accepted as the mode of separation in the nebular hypothesis, but, as already stated, this is held by Mr. See to be exceptional. He thus regards the ring of Saturn as being as exceptional in its history as it now is in appearance. Where he maintains that Saturn's ring will never coalesce into a satellite, he might with advantage have referred to the remarkable investigations of M. Roche,[1] who showed that a satellite would be torn to pieces by tidal action if it revolved at a distance of less than 2·44 times the planet's radius. We may here note the interesting fact that whilst Saturn's ring almost touches "Roche's limit" on the inside, the Martian satellite, Phobus, and the fifth satellite of Jupiter[2] almost touch it on the outside.[3]

In order to prove his thesis as to the highness of the eccentricity and the comparability of masses, Mr. See gives a careful table of the observed elements of the orbits and of the relative brightnesses of seventy-three pairs of double stars. The values of the elements are of course open to much uncertainty, but the mean eccentricity, which is found to be ·45, must lie near the truth. In the few cases in which the masses have been determined, they are found to be comparable, and the comparability of the brightnesses confirms the generality of this law. Thus the facts of observation agree with our author's ideas.

Mr. See must be congratulated on having written an essay of great cosmogonical interest, and although his theory may never be susceptible of exact proof, yet there is sufficient probability of his correctness to inspire us with fresh interest in the observations of double stars.

G. H. DARWIN.

MAGNETIC INDUCTION IN IRON AND OTHER METALS.

Magnetic Induction in Iron and other Metals. By J. A. Ewing, F.R.S. [1] (London: *Electrician* Office.)

IN this admirable book Prof. Ewing has brought together matter which was before to be found only in the journals of learned societies, and he has also given a full account of his own researches in magnetism. The book is written in a lucid style, and is supplied with numerous references to original papers.

In Chapter I. Prof. Ewing explains clearly the meaning of such terms as "intensity of magnetisation" and the like, which many students have difficulty in understanding. As stated in the preface, he has "endeavoured to familiarise the student with the notion of intensity of magnetisation (I) as well as with the notion of magnetic induction (B)." When endless magnetic circuits are discussed, it is convenient to talk of "permeability" and "induction"; on the other hand, "magnetic poles" and "magnetisation" are just as important when permanent magnets are dealt with. The magnetisation of ellipsoids and the influence of the shape and dimensions of magnetised bodies upon magnetic quality are fully treated.

[1] "Acad. des Sciences de Montpelier," vol. i. (1847–50), p. 243. See also Darwin, *Harper's Magazine*, June, 1889.

[2] The values given by Barnard (NATURE, p. 377) make the distance 112,000 miles, and Roche's limit 107,000 miles.

[3] It is proper to warn the reader that Roche's limit depends to some extent on the density of the planet. For the sun it will be about one-tenth of the earth's distance from the sun. Thus a body of planetary size cannot move in a highly eccentric orbit, so that its perihelion distance is one-tenth, without being broken up into meteorites; and conversely a flight of meteorites with less than the same perihilion distance can never coalesce into a planet.

Chapters II. and III. are devoted to measurements of magnetic quality by the magnetometer and ballistic methods. With respect to the former very full information is given as to the construction of the apparatus and its use.

The earth's coil as a means for calibrating the Ballistic Galvanometer is fully explained, as also that of a solenoid and current. Mention is not made of a convenient method of calibration in which the quantity of electricity passed is given directly by $Q = \frac{A}{a}\frac{\tau}{2\pi}$; where A is the deflection corrected for decrement; a is the steady deflection due to unit current, and τ is the periodic time of the ballistic needle. Here a and τ are quantities very readily obtained.

The chapter concludes with a full description of Dr. Hopkinson's "Bar and Yoke" method.

Chapter IV. contains valuable information with regard to curves of induction and hysteresis in the case of wrought iron, steel, and cast iron, which will be of use to the electrical engineer in the design of dynamo electric machinery. The effects of annealing and stretching iron are brought forward and well illustrated.

The next chapter, on magnetic hysteresis, is perhaps the most important in the book. It commences by giving a clear definition of hysteresis, the effects of which are amply illustrated by curves, and stress is laid upon the definition of permeability as being the ratio of B to H *with certain limitations.*

The dissipation of energy through magnetic hysteresis —which plays such an important part in the design of cores for transformers, and the armatures of dynamos—is fully treated.

The remarks on magnetic viscosity towards the end of the chapter are worthy of very careful consideration. The author points out that in the case of quick cycles, $\int H dI$ may be widely different from what is found to be the case by static methods, and further remarks that experimental evidence is wanting under this head.[1]

Chapter VI. treats of magnetism in weak fields. The author refers to experiments by Lord Rayleigh and himself, in which the time effect upon magnetism is clearly shown—the creeping up of the magnetism going on for a considerable time.

Magnetism in strong fields is discussed in Chapter VII. The "Isthmus Method" introduced by the author and Mr. W. Low in 1887 is capable of producing magnetic fields of enormous strength. In giving his conclusions from experiments by the isthmus method the author states, "there is apparently no limit to the value to which the induction may be raised. But, when we measure magnetisation by the intensity of magnetism I, we are confronted with a definite limit—a true saturation value, which is reached or closely approached by the application of a comparatively moderate magnetic force."

A full account of Dr. Hopkinson's researches on the effect of temperature on magnetism is given in Chapter VIII., and reference is made to the identification of recalescence with recovery of the magnetic state. In the latter part of the chapter hysteresis, in the relation of magnetic susceptibility to temperature, is dealt with; and mention is made of the wide range of temperature through which the alloys of iron and nickel may exist in either the magnetic or non-magnetic state.

Reference is made to the researches on recalescence of Osmond, who has since shown the marked influence of the initial temperature, and the rate of cooling on recalescence in the case of chromium steel. Dr. Bottomley has shown that the alloys of chromium and steel in the unannealed state have exceptionally high magnetic qualities, which are confirmed by experiments of Dr. Hopkinson.

In Chapter X. the magnetic circuit is discussed, and the way in which it is applied to the design of dynamo electric machines and transformers. Reference is made to the important work of Drs. J. and E. Hopkinson and Kapp upon this subject—more especially in connection with dynamo electric machinery. In pursuing the analogy of the magnetic circuit to the ordinary conduction equation, Prof. Ewing lays stress upon the fact that the permeability (μ) is a function of the induction (B), and this is a point which cannot be too strongly urged. Much that is in this chapter has great practical importance—the treatment of the subject being considered from a graphical, as well as analytical, point of view. The chapter ends with an account of the influence upon magnetism by cuttings and the compression of joints in magnetic circuits.

The last chapter gives a complete account of the different theories of magnetism. Weber's theory is discussed with modifications by Maxwell and Wiedemann, to which are added Prof. Ewing's own views of the subject. He goes on to show that the reduction of hysteresis by vibration is explained by the molecular theory of magnetism,—and further supposes that time-lag in magnetism can be accounted for by it. The book ends with an account of Ampère's hypothesis of magnetic molecules.

E. WILSON.

[1] For recent experiments upon Magnetic Viscosity see a paper by J. Hopkinson, F.R.S., and B. Hopkinson in *Electrician*, September 9, 1892.

OUR BOOK SHELF.

Forschungsberichte aus der Biologischen Station zu Plön. Theil I. Faunistische und biologische Beobachtungen am Gr. Plöner See. Von Dr. Otto Zacharias, Direktor der Biologischen Station. (Berlin: R. Friedländer und Sohn, 1893.)

THE first report of investigations from the biological station of Plön, in Holstein, has just been issued. It is a journal of 52 pages with one plate, bearing on the front of the cover a neat representation of the turreted three-storey building reflected in the quiet waters of the inland lake, and on the back a list of the regulations observed in the management of the station.

In his introductory remarks the Director, who has already made his views known with regard to the importance of freshwater laboratories in the pages of several German scientific periodicals, gives a brief sketch of the advance already made in this direction in Italy, France, and America.

The first paper gives a list of the fauna at present known to inhabit the lake. This occupies seven pages; and fourteen names, being printed in italics, signify that they are new to science. The new species and genera are treated in detail in the second paper. The greatest

number occur amongst *Rotatoria*, but additions are also made to the *Rhizopods*, *Heliozoa*, and *Infusoria*. No new forms appear to have been found amongst the crustacea, mollusca, or fishes.

A third paper deals with the distribution and special natural history of the forms met with, and with the comparison of the plankton at different seasons.

There are no foot-notes through the number, but all references to literature are formed into a numbered table at the end. The plate, which is one of Klinkhardt's, of Leipzig, shows a number of the new forms discovered.

The investigations are almost entirely on the minute floating organisms, as must necessarily be the case at this date with all freshwater work not connected directly with pisciculture.

The British Journal Photographic Almanac for 1893. Edited by J. Traill Taylor. (London: Henry Greenwood, and Co., 1893.)

THIS annual volume contains, as usual, a vast amount of useful information gathered from workers in all the various applications of photography. After a brief summary, in which the editor refers to some of the chief advances made in the science of photography during the past year, mentioning, for instance, Mr. Dallmeyer's telephotographic lens, Mr. Willis's improvement in the p'atinotype process, &c., he devotes a few pages to "some photographic methods of book illustration." Then come short contributions in which everyone has something special to say, whether it relates to a new mounting medium, a permanent toning bath, or pinhole pictures, &c. They are far too numerous to mention individually, but will be found most interesting reading. "Epitome of Progress" is the title of a series of notes by Mr. Traill Taylor, in which he refers briefly, and in some cases at length, to new methods, remedies, &c., and instruments used in the practice of the art. The formulæ and tables are as numerous as ever, while all the other information, such as lists of photographic societies, &c., have been brought up to date. The volume is copiously illustrated.

Studies in Corsica. By John Warren Barry, M.A. (London: Sampson Low, Marston, and Co., 1893.)

MR. BARRY has twice visited Corsica, the first visit being of less than five months' duration, while the second extended from September 1882 to February 1885. He has thus had ample opportunities for the study both of the island and of its people, and in the present volume he sums up his impressions very brightly and pleasantly. Most readers will probably like best the chapters on life at Ajaccio, but they will also find much to interest them in what the author has to say about the Bush of Corsica and of the Mediterranean region.

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.*]

Luminous Earthworms.

I HAVE recently received from a correspondent a statement which is sufficiently valuable to crave public attention. It opens up withal a very fascinating field of investigation, and one which, though it has by no means been altogether neglected by foretime naturalists, is as yet far from being fully understood.

Writing from Richmond, Surrey, the Rev. Alfred Geden, M.A., says:—"I have just heard of a phenomenon in the worm world which is new to me . . . My sister declares that one day last summer, in a village on the Thames, she saw a 'phosphorescent worm,' and describes the creature as about one and a half inches long, worm-like in all respects. My sister is sure it was not an ordinary glow-worm, with which she is perfectly familiar; and, moreover, she called the attention of a cousin to the creature at the time, who corroborates her account. Are there worms in England capable of emitting light besides the glow-worm? If so, are they at all common?"

In reply to a series of questions, I was able to elicit these further particulars:—"It was in a garden in the village of Long Wittenham, near Didcot, on a dark evening in the latter part of September last [1892], or the beginning of October. My sister's attention was attracted by the light on the ground, and she picked the worm up. While she cannot positively assert that she saw it in motion on the ground, it certainly wriggled in her hand. For a few seconds also after putting it down her fingers remained phosphorescent."

The notice of the public, so far as I have been able to ascertain, was first directed to this phenomenon among earthworms by Grimm in 1670, but scientific observation, as we now understand it, was then scarcely known. A century elapsed before any further record was made in the periodicals of Europe which I have consulted, then came a paper by Flaugergues in 1781. This article, which appeared in Lichtenberg's magazine, was written in German. In 1873 Cohn's observations on the same subject were published in the well-known *Zeitschrift für Wissensch. Zool.*, while numerous recent writers have further contributed to our knowledge, especially in relation to the Continental species.

Thus in 1872 an article appeared in the French Annals of Natural Science, by Panceri, entitled "Studies in the Phosphorescence of Marine Animals," in which he states that the luminosity observed in the case of certain (earth) worms is due to a secretion from the girdle, where special glands exist, and that by the evolution of light there was no perceptible raising of the temperature. In this respect, therefore, the earthworm's glow corresponds with that emitted by the firefly, Noctiluca, and glow-worm. One investigator at least has tested the colour and composition of the luminosity by the spectroscope, and says that it is not uni-coloured or monochromatic, but compounded chiefly of the red and violet rays. Other students regard the substance which produces the light as homogeneous.

In 1838 Eversmann published an article on a night-shining worm in Russian, and in 1871 an English naturalist named Breese delivered an address on the earthworm before the West Kent Natural History Society, from a meagre abstract of which we learn that he had spent some years on the subject of annelid luminosity, having studied it historically from the year 1805, when Viviani wrote on the phosphorescence of the sea, down to the date of his own delivery. According to Breese the luminosity exists in the excreted glutinous material with which the outer skin of the animal is covered.

More than one creature has at different times borne the name of the phosphorescent worm. In 1837 Dugès, a French writer, described a species under this name (*Lumbricus phosphoreus*), with a girdle extending from the 13th to the 16th segments, and a somewhat flattened body behind. After the lapse of exactly half a century this curious creature was examined again, and named by Giard Photodrilus, or the luminous worm. It has eight setæ, just as our common species have, but they are separate, and not in couples. There is no gizzard, nor does the lip dovetail into the segment behind. It is a small, transparent, rose-coloured worm, and decidedly phosphorescent.

In 1843 when the British Association met at Cork, specimens of an annelid were exhibited by Dr. Allman, which he had discovered in the bogs of the south of Ireland, and which was the cause of a luminous appearance. When irritated the worm gave out a phosphorescent light, which is said to have been much increased by exposing the creature to the vapour of alcohol. The light was of that peculiar soft greenish hue which is characteristic of the phosphoresence observed in light-giving animals, and familiar to most readers in connection with the glow-worm. Another gentleman was reported to have observed the same peculiarity in some annelids which exist in the bogs of Connaught. I have been unable to find any recent reference to or confirmation of these curious observations. Ten years later Mr. Henry Cox exhibited an earthworm which was phosphorescent at a meeting of the Literary and Philosophical Society of Liverpool, held November 14, 1853.

While few records of a trustworthy nature respecting the observation of luminous worms in Britain are available, a good deal has been done by our Continental fellow-workers. Vejdovsky, who wrote a very valuable work on the various species of an-

nelids in 1884, gives us some results of his personal experience, which I believe have never been placed before the English reader. He says that he had the good fortune once at least to observe an interesting case of phosphoresence in connection with the brandling. It was one warm July night in the year 1881, when he was exploring a dung-heap. Naturalists do not usually work with kid gloves and diamond rings. Presently a spot of soft, bluish-white light appeared, which, however, was changeful and unsteady. Now it would disappear, then return anew and shine forth over a larger space, though never with a brilliant hue. He thereupon removed a portion of the manure from the spot where he had observed the luminosity, and found that the light appeared brighter, and shone for a longer time without disappearing, or before it migrated to another spot. By means of a lantern Vejdovsky was able to secure a large number of specimens of the brandling from the dung-heap, which he placed in a vessel for the purpose of subjecting them to careful observation. To his great surprise he found that his finger soon glowed in the darkness with the phosphorescence, which extended generally over the hand where it came into contact with the worms. It was therefore apparent that the luminosity was the product of a fluid secreted by the cutaneous glands, which had attached itself to the hand of the investigator, and now manifested itself in this curious way.

We have an interesting observation on the same subject by Prof. von Stein, which was published at Leipzig in 1883. One evening in the middle of September the Professor was spending some time with a circle of friends at a parsonage not far from Potsdam, when the conversation turned upon phosphorescence and the phenomena of light. Hereupon one of the younger members of the family—who are usually the keenest and most shrewd observers of Nature, and the best friends of the naturalist—observed that there were fountains in the adjoining gardens, the water from which was frequently observed to be full of light-bearing creatures when it was violently agitated. He regarded the affair at first simply as a hoax, or an attempt to make a fool of him—as people are ever ready to do with a hobby-rider—but ascertained eventually that the luminosity was due to the presence of a species of worm which possessed the property of shining when disturbed. As with Vejdovsky, so with Prof. von Stein, the finger which had come into contact with the worm continued to glow for some time after. What species of worm was under observation is not recorded.

It now becomes a question, What end could be served thereby? The philosopher no sooner learns a new fact than he begins to pry into the secret which lies beneath, and stands to it as cause to effect. We have analogy to guide us. The water worms may be compared with the marine animals which produce phosphorescence, while the brandling may be studied in the light of the glow-worm. It may be objected that as worms have no eyes there can be no advantage in their luminosity. But such an argument would be based on the erroneous assumption that a creature without eyes is incapable of receiving impressions from light. That worms are influenced by light is proved both by their habit of avoiding light, and by the experiments which have been carried out by various students. Darwin remarks that as worms are destitute of eyes he at first thought they were quite insensible to light. He found, however, that "light affects worms by its intensity and by its duration." Hoffmeister states that with the exception of a few individuals worms are extremely sensitive to light, and from my own observations I have been able to demonstrate that there are marked differences in the susceptibility of the different species—some being very much more susceptible than others.

Now it follows that if a number of species of worms lived together in one place, as they usually do in a manure heap, it would be a great advantage for a given species to possess a distinguishing feature, such as that of luminosity, to enable two individuals to discover each other's whereabouts, just as the male glow-worm detects the female by the light emitted from her upturned abdomen. We have, moreover, the fact that certain species of earthworm are characterised by a peculiar odour, which must be of great service in preventing promiscuous copulation and hybridity. Though earthworms are destitute of nasal organs they can detect odours, and though sightless they are affected by light.

Viewed in this light a new field of research is opened up which hitherto has been totally unworked, but which may be hoped to yield remarkable results if diligently, patiently, and intelligently tilled.

It would be an easy thing for any one living in the country, with access to an old manure heap, where the brandling (*Allolobophora fœtida*, Sav.) usually abounds, to ascertain whether such luminosity is of common occurrence, and it would be exceptionally valuable to record the period of the year, the state of the atmosphere, the age of the moon, and other data which would enable the specialist to arrive at a satisfactory conclusion. I shall be glad to receive communications, addressed "The Grove, Idle, Bradford," from observers who may find pleasure in such pursuits. HILDERIC FRIEND.

Quaternions and the Algebra of Vectors.

IN a recent number of this Journal (p. 151) Mr. McAulay puts certain questions to Mr. Heaviside and to me, relating to a subject of such importance as to justify an answer somewhat at length. I cannot of course speak for Mr. Heaviside, although I suppose that his views are not very different from mine on the most essential points, but even if he shall have already replied before this letter can appear, I shall be glad to add whatever of force may belong to independent testimony.

Mr. McAulay asks: "What is the *first* duty of the physical vector analyst *quâ* physical vector analyst?" The answer is not doubtful. It is to present the subject in such a form as to be most easily acquired, and most useful when acquired.

In regard to the slow progress of such methods toward recognition and use by physicists and others, which Mr. McAulay deplores, it does not seem possible to impute it to any want of uniformity of notation. I doubt whether there is any modern branch of mathematics which has been presented for so long a time with a greater uniformity of notation than quaternions.

What, then, is the cause of the fact which Mr. McAulay and all of us deplore? It is not far to seek. We need only a glance at the volumes in which Hamilton set forth his method. No wonder that physicists and others failed to perceive the possibilities of simplicity, perspicuity, and brevity which were contained in a system presented to them in ponderous volumes of 800 pages. Perhaps Hamilton may have intended these volumes as a sort of *thesaurus*, and we should look to his shorter papers for a compact account of his method. But if we turn to his earlier papers on Quaternions in the *Philosophical Magazine*, in which principally he introduced the subject to the notice of his contemporaries, we find them entitled "On Quaternions; or on a New System of Imaginaries in Algebra," and in them we find a great deal about imaginaries, and very little of a vector analysis. To show how slowly the system of vector analysis developed itself in the quaternionic *nidus*, we need only say that the symbols S, V, and ∇ do not appear until two or three years after the discovery of quaternions. In short, it seems to have been only a secondary object with Hamilton to express the geometrical relations of vectors,—secondary in time, and also secondary in this, that it was never allowed to give shape to his work.

But this relates to the past. In regard to the present *status*, I beg leave to quote what Mr. McAulay has said on another occasion (see *Phil. Mag.* June, 1892):—"Quaternions differ in an important respect from other branches of mathematics that are studied by mathematicians after they have in the course of years of hard labour laid the foundation of all their future work. In nearly all cases these branches are very properly so called. They each grow out of a definite spot of the main tree of mathematics, and derive their sustenance from the sap of the trunk as a whole. But not so with quaternions. To let these grow in the brain of a mathematician, he must start from the seed as with the rest of his mathematics regarded as a whole. He cannot graft them on his already flourishing tree, for they will die there. They are independent plants that require separate sowing and the consequent careful tending."

Can we wonder that mathematicians, physicists, astronomers, and geometers feel some doubt as to the value or necessity of something so separate from all other branches of learning? Can that be a natural treatment of the subject which has no relations to any other method, and, as one might suppose from reading some treatises, has only occurred to a single man? Or, at best, is it not discouraging to be told that in order to use the quaternionic method, one must give up the progress which he has already made in the pursuit of his favourite science, and go back to the beginning and start anew on a parallel course?

I believe, however, that if what I have quoted is true of vector methods, it is because there is something fundamentally wrong

in the presentation of the subject. Of course, in some sense and to some extent it is and must be true. Whatever is special, accidental, and individual, will die, as it should; but that which is universal and essential should remain as an organic part of the whole intellectual acquisition. If that which is essential dies with the accidental, it must be because the accidental has been given the prominence which belongs to the essential. For myself, I should preach no such doctrine to those whom I wish to convert to the true faith.

In Italy, they say, all roads lead to Rome. In mechanics, kinematics, astronomy, physics, all study leads to the consideration of certain relations and operations. These are the capital notions; these should have the leading parts in any analysis suited to the subject.

If I wished to attract the student of any of these sciences to an algebra for vectors, I should tell him that the fundamental notions of this algebra were exactly those with which he was daily conversant. I should tell him that a vector algebra is so far from being any one man's production that half a century ago several were already working toward an algebra which should be primarily geometrical and not arithmetical, and that there is a remarkable similarity in the results to which these efforts led (see Proc. A.A.A.S. for 1886, pp. 37, ff.). I should call his attention to the fact that Lagrange and Gauss used the notation $(\alpha\beta\gamma)$ to denote precisely the same as Hamilton by his $S(\alpha\beta\gamma)$, except that Lagrange limited the expression to unit vectors, and Gauss to vectors of which the length is the secant of the latitude, and I should show him that we have only to give up these limitations, and the expression (in connection with the notion of geometrical addition) is endowed with an immense wealth of transformations. I should call his attention to the fact that the notation $[r_1r_2]$, universal in the theory of orbits, is identical with Hamilton's $V(\rho_1\rho_2)$, except that Hamilton takes the area as a vector, *i.e.* includes the notion of the direction of the normal to the plane of the triangle, and that with this simple modification (and with the notion of geometrical addition of surfaces as well as of lines) this expression becomes closely connected with the first-mentioned, and is not only endowed with a similar capability for transformation, but enriches the first with new capabilities. In fact, I should tell him that the notions which we use in vector analysis are those which he who reads between the lines will meet on every page of the great masters of analysis, or of those who have probed deepest the secrets of nature, the only difference being that the vector analyst, having regard to the weakness of the human intellect, does as the early painters who wrote beneath their pictures "This is a tree," "This is a horse."

I cannot attach quite so much importance as Mr. McAulay to uniformity of notation. That very uniformity, if it existed among those who use a vector analysis, would rather obscure than reveal their connection with the general course of modern thought in mathematics and physics. There are two ways in which we may measure the progress of any reform. The one consists in counting those who have adopted the *shibboleth* of the reformers; the other measure is the degree in which the community is imbued with the essential principles of the reform. I should apply the broader measure to the present case, and do not find it quite so bad as Mr. McAulay does.

Yet the question of notations, although not the vital question, is certainly important, and I assure Mr. McAulay that reluctance to make unnecessary innovations in notation has been a very powerful motive in restraining me from publication. Indeed my pamphlet on "Vector Analysis," which has excited the animadversion of quaternionists, was never formally published, although rather widely distributed, so long as I had copies to distribute, among those who I thought might be interested in the subject. I may say, however, since I am called upon to defend my position, that I have found the notations of that pamphlet more flexible than those generally used. Mr. McAulay, at least, will understand what I mean by this, if I say that some of the relations which he has thought of sufficient importance to express by means of special devices (see Proc. R. S. E., for 1890–91), may be expressed at least as briefly in the notations which I have used, and without special devices. But I should not have been satisfied for the purposes of my pamphlet with any notation which should suggest even to the careless reader any connection with the notion of the quaternion. For I confess that one of my objects was to show that a system of vector analysis does not require any support from the notion of the quaternion, or, I may add, of the imaginary in algebra.

I should hardly dare to express myself with so much freedom, if I could not shelter myself behind an authority which will not be questioned.

I do not see that I have done anything very different from what the eminent mathematician upon whom Hamilton's mantle has fallen has been doing, it would seem, unconsciously. Contrast the system of quaternions, which he has described in his sketch of Hamilton's life and work in the *North British Review* for September, 1866, with the system which he urges upon the attention of physicists in the *Philosophical Magazine* in 1890. In 1866 we have a great deal about imaginaries, and nearly as much about the quaternion. In 1890 we have nothing about imaginaries, and little about the quaternion. Prof. Tait has spoken of the calculus of quaternions as throwing off in the course of years its early Cartesian trammels. I wonder that he does not see how well the progress in which he has led may be described as throwing off the yoke of the quaternion. A characteristic example is seen in the use of the symbol ∇. Hamilton applies this to a vector to form a quaternion, Tait to form a linear vector function. But while breathing a new life into the formulæ of quaternions, Prof. Tait stands stoutly by the letter.

Now I appreciate and admire the generous loyalty toward one whom he regards as his master, which has always led Prof. Tait to minimise the originality of his own work in regard to quaternions, and write as if everything was contained in the ideas which flashed into the mind of Hamilton at the classic Brougham Bridge. But not to speak of other claims of historical justice, we owe duties to our scholars as well as to our teachers, and the world is too large, and the current of modern thought is too broad, to be confined by the *ipse dixit* even of a Hamilton.

J. WILLARD GIBBS.

Glacial Drift of the Irish Channel.

IT seems of interest to record that the eurite or microgranite containing blue amphibole (Riebeckite), the rock noticed by Mr. P. F. Kendall in the drifts of the Isle of Man and Caernarvonshire, occurs abundantly in the form of small pebbles on the shore at Killiney, co. Dublin, doubtless derived from the "glacial gravels" of the coast. I have also found a pebble in the raised beach at Greenore, co. Down.

Mr. Teall's description of the rock of Ailsa Craig (*Mineralogical Magazine*, vol. ix. p. 219) enabled the very characteristic pebbles collected by Mr. Kendall to be referred to that mass as a source, or to formerly existing bosses south of or adjacent to it. As far as I am aware, all the material is in the form of pebbles, often only an inch in diameter. This is hardly likely to be its original condition, if removed by ice from Ailsa Craig, and is only one of many points that indicate a redistribution of our so-called "glacial" beds by subsequent action of rivers or other waters.

GRENVILLE A. J. COLE.

Royal College of Science for Ireland, Dublin,
March 12.

THE SACRED NILE.

THAT Egypt is the gift of the Nile is a remark we owe to the father of history, who referred not only to the fertilising influence of the stream, but to the fact that the presence of the Nile and its phenomena are the conditions upon which the habitability of Egypt altogether depends. That that part of Egyptian archæology and myth which chiefly interests astronomers is also the gift of the Nile is equally true.

The heliacal rising of Sirius and other stars at the time of the commencement of the inundations each year; all the myths which grew out of the various symbols of the stars so used, are so many evidences of the large share the river, with its various water levels at different times, had in the national life. It was, in fact, the true and unique basis of the national life.

In this the Nile had a compeer, or even compeers. What the Nile was to Egypt the Euphrates and Tigris were to a large region of Western Asia, where also we find the annual flood to have been in ancient times a source of fertility over an enormous area which is now

desert, the plains being broken by the remains of the ancient canals.

What more natural than that Euphrates, Tigris and Nile were looked upon as deities; that the Gods of the Nile valley on the one hand, and of the region watered by the Euphrates and Tigris on the other, were gods to swear by; that they were worshipped in order that their benign influences might be secured, and that they had their local shrines and special cults.

The god sacred to the Euphrates and Tigris was called Ea. The god sacred to the Nile was called Hapi.

The name Hapi is the same as that of the bull Apis, the worship of which was attributed to Mena.[1] Certainly Mena, Mini, or Menes, as he is variously called, was fully justified in founding the cult of the river god, for he first among men appears to have had just ideas of irrigation; and I have heard the distinguished officers who have lately been responsible for the irrigation system of to-day speaking with admiration of the ideas and works of Menes.

Whether the Tigris had a Menes in an equally early time is a point on which history is silent; but, according to the accounts of travellers, the Tigris in flood is even more majestic than the Nile, and yet the latter river in flood is a sight to see—a whole fertile plain turned into, as it were, an arm of the sea, with here and there an island, which on inspection turns out to be a village, the mud houses of which too often are undermined by the lapping of the waves in the strong north wind.

There is no doubt that the dates of the rise of these rivers not only influenced the national life but even the religions of the dwellers on their banks. The Euphrates and Tigris rise about the time of the spring equinox—the religion was equinoxial, the temples were directed to the east. The Nile rises at a solstice—the religion was solstical and the solar temples were directed no longer to the east. To the Egyptians the coming of the river to the parched land was as the sunrise chasing the darkness of the night; the sun-god of day conquering the star-gods of night; or again the victorious king of the land slaughtering his enemies.

By no one, perhaps, have the impressions produced by the various phases of the river been so poetically described as by Osburn, a writer of vivid imagination, but it must be added that the facts detailed in his description are not exactly capable of being verified by engineering science. Osburn thus describes the low Nile:

"The Nile has shrunk within its banks until its stream is contracted to half its ordinary dimensions, and its turbid, slimy, stagnant waters scarcely seem to flow in any direction. Broad flats or steep banks of black, sun-baked Nile mud, form both the shores of the river. All beyond them is sand and sterility; for the hamseen, or sand-wind of fifty days' duration, has scarcely yet ceased to blow. The trunks and branches of trees may be seen here and there through the dusty, hazy, burning, atmosphere, but so entirely are their leaves coated with dust, that at a distance they are not distinguishable from the desert sand that surrounds them. It is only by the most painful and laborious operation of watering that any tint approximating to greenness can be preserved at this season even in the pleasure-gardens of the Pacha. The first symptom of the termination of this most terrible season is the rising of the north wind (the Etesian wind of the Greeks), blowing briskly, often fiercely during the whole of the day. The foliage of the groves that cover Lower Egypt is soon disencumbered by it of the dust, and resumes its verdure. The fierce fervours of the sun, then at his highest ascension, are also most seasonably mitigated by the same powerful agency, which prevails for this and the three following months throughout the entire land of Egypt."

[1] Maspero, "Hist. Anc." xi. 10.

Then at last comes the inundation:—

"Perhaps there is not in Nature a more exhilarating sight, or one more strongly exciting to confidence in God, than the rise of the Nile. Day by day and night by night, its turbid tide sweeps onward majestically over the parched sands of the waste, howling wilderness. Almost hourly, as we slowly ascended it before the Etesian wind, we heard the thundering fall of some mud-bank, and saw by the rush of all animated Nature to the spot, that the Nile had overleapt another obstruction, and that its bounding waters were diffusing life and joy through another desert. There are few impressions I ever received upon the remembrance of which I dwell with more pleasure than that of seeing the first burst of the Nile into one of the great channels of its annual overflow. All Nature shouts for joy. The men, the children, the buffaloes, gambol in its refreshing waters, the broad waves sparkle with shoals of fish, and fowl of every wing flutter over them in clouds. Nor is this jubilee of Nature confined to the higher orders of creation. The moment the sand becomes moistened by the approach of the fertilising waters, it is literally alive with insects innumerable. It is impossible to stand by the side of one of these noble streams, to see it every moment sweeping away some obstruction to its majestic course, and widening as it flows, without feeling the heart to expand with love and joy and confidence in the great Author of this annual miracle of mercy."

The effects of the inundation, as Osburn shows in another place, "exhibit themselves in a scene of fertility and beauty such as will scarcely be found in another country at any season of the year. The vivid green of the springing corn, the groves of pomegranate trees ablaze with the rich scarlet of their blossoms, the fresh breeze laden with the perfumes of gardens of roses and orange thickets, every tree and every shrub covered with sweet-scented flowers. These are a few of the natural beauties that welcome the stranger to the land of Ham. There is considerable sameness in them, it is true, for he would observe little variety in the trees and plants, whether he first entered Egypt by the gardens of Alexandria or the plain of Assouan. Yet is it the same everywhere, only because it would be impossible to make any addition to the sweetness of the odours, the brilliancy of the colours, or the exquisite beauty of the many forms of vegetable life, in the midst of which he wanders. It is monotonous, but it is the monotony of Paradise."

"The flood reaches Cairo on a day closely approximating to that of the summer solstice. It attains its greatest height, and begins to decline near the autumnal equinox. By the winter solstice the Nile has again subsided within its banks and resumed its blue colour. Seed-time has occurred in this interval. The year in Egypt divides itself into three seasons—four months of sowing and growth, corresponding nearly with our November, December, January, and February; four months of harvest from March to June; the four months of the inundation completing the cycle."

In order to show how the astronomy of the ancient Egyptians—to deal specially with them—was to a large extent concerned with the annual flood and all that depended upon that flood, and how the first solar year used on this planet, so far as we know, was established, it is important to study the actual facts of the rise somewhat closely, not only for Egypt generally, but for several points in the line some thousand miles in extent, along which in the earliest times cities and shrines were dotted here and there.

Time out of mind the fluctuations in the height of the river have been carefully recorded at different points along the river. In the "Description de l'Egypt" we find a full description of the so-called nilometer at Assuan (First Cataract) which dates from a remote period, perhaps as early as the 5th Dynasty.

In Ebers' delightful book on Egypt space is given to

the description of the much more modern one located at Rodah.

The nilometer, or "mikyas," on the island of Rodah now visible, is stated to have replaced one which was brought thither from Memphis at some unrecorded date. Makreezee in 1417, according to Ebers, saw the remains of the older nilometer.

The present mikyas is within a covered vault or chamber, the roof being supported on simple wooden pillars. In a quadrangular tank communicating with the river by a canal is an octagon pillar on which the Arabic measurements are inscribed. These consist of the pic (variously called ell or cubit) = 0·54 metre, which is divided into twenty-four kirats, in consequence of the rise of the river bed in relatively recent times, the nilometer is submerged at high Nile to a depth of two cubits.

The rise of the Nile can now be carefully studied, as gauges are distributed along the river. We have the Aswân gauge from 1869, the Armant gauge from 1887, the Suhag gauge from 1889, and the Asyût gauge from 1882. The distances of these gauges from Aswân are as follows:—

	Kilometres
Aswân	0
Armant	200
Suhag	447
Asyût	550
Rodah	941

The Rodah gauge is not to be depended on as the movements of the Barrage regulation destroy its value as a record. The heights of the zeros of these gauges above mean sea level are as follows:—

	Metres.
Aswân	84·158
Armant	69·535
Suhag	56·00
Asyût	53·10
Rodah	13·14

Great vagueness arises in there being no very obvious distinction between the gauge readings reached in summer and that from which the rise is continuous. There are apparently rainfalls in the end of spring of sufficient power to raise the Nile visibly in summer, just as muddy rises have been seen in winter to pass down the valley, leaving a muddy mark on the rocks at Aswân and Manfalût. Independently of the actual gauge-reading of the rise, there are facts about it which strike every beholder. At the commencement of the rise we have the *green water*. This occurs in June, but varies in date as much as the top of the flood varies.

From the fact that modern observations show that the very beginning of the rise, and the first flush, second flush, and final retirement vary, it seems evident that the ancient Egyptians could not have had any fixed zero-gauge or time for the real physical fact of the rise, but must have either deduced from a series of observations a mean period of commencement, or a mean arrival of the red water, or a mean rising up to a certain gauge.

First to deal with the green water. Generally when the rise of an inch or two is reported from the nilometer at Rodah, the waters lose the little of clearness and freshness they still possessed. The green colour is the lustreless hue of brackish water within the tropics, and only the finer class of modern filter can render such water clear. The colour is really due to algæ.

Happily, the continuance of this state of the water seldom exceeds three or four days. The sufferings of those who are compelled to drink it in this state, from vesicary disease, even in this short interval, are very severe. The inhabitants of the cities generally provide against it by Nile-water stored in reservoirs and tanks.

Col. Ross, R.E., noticed in 1887 and in 1890, when, owing to the slow retreat of the Nile, the irrigation officers had to hold back many basins in the Gizah province; and also in 1888, when the water remained long stagnant; that the basin-water got green—showed the algæ and smelt marshy, just as the June green water does.

Hence it has been argued that as the Nile-water in the bed of the stream—even in very slow-flowing back-waters—does not become green, the greenness must be produced by an almost absolute stagnation of the water. We know of great marshes up above Gondokoro, and hence it is thought that the green water of summer, which comes on suddenly, is this marsh-water being pushed out by the new water from behind, and that is why it heralds the rise. No one has so far minutely observed the gradual intrusion of the green water.

The rise of the river proceeds rapidly, and the water gradually becomes more turbid. Ten or twelve days, however, elapse before the development of the last and most extraordinary of all the appearances of the Nile, thus described by Mr. Osborn[1]:—"It was at the end of—to my own sensations—a long and very sultry night, that I raised myself from the sofa upon which I had in vain been endeavouring to sleep, on the deck of a Nile boat that lay becalmed off Benisoueff, a town of Middle Egypt.

"The sun was just showing the upper limb of his disc over the eastern mountains. I was surprised to see that when his rays fell upon the water, a deep ruddy reflection was given back. The depth of the tint increased continually as a larger portion of his light fell upon the water, and before he had entirely cleared the top of the hill it presented the perfect appearance or a river of blood. Suspecting some delusion, I rose up hastily, and looking over the side of the boat saw there the confirmation of my first impression. The entire body of the water was opaque and of a deep red colour, bearing a closer resemblance to blood than to any other natural production to which it could be compared. I now perceived that during the night the river had visibly risen several inches. While I was gazing at this great sight, the Arabs came round me to explain that it was the Red Nile. The redness and opacity of the water, in this extraordinary condition of the river, are subject to constant variations. On some days, when the rise of the river has not exceeded an inch or two, its waters return to a state of semi-transparency, though during the entire period of the high Nile they never lose the deep red tinge which cannot be separated from them. It is not, however, like the green admixture, at all deleterious; the Nile water is never more wholesome or more deliciously refreshing than during the overflow. There are other days when the rise of the river is much more rapid, and then the quantity of mud that is suspended in the water exceeds, in Upper Egypt, that which I have seen in any other river. On more than one occasion I could perceive that it visibly interfered with the flow of the stream. A glassful of it in this state was allowed to remain still for a short time. The upper portion of it was perfectly opaque and the colour of blood. A sediment of black mud occupied about one quarter of the glass. A considerable portion of this is deposited before the river reaches Middle and Lower Egypt. I never observed the Nile water in this condition there, and indeed no consecutive observations exist of the reddening of the water. It is quite clear that the reddening cannot come from the White Nile, but must be the first floods of the Blue Nile and the Atbara coming down."

Rate of Rise of the Nile.—The rate in flood is 1¾ days from Wady Halfa to Aswân and six days from Aswân to Rodah (941 kilometres). In very high Niles this is perhaps accelerated to five days. In the early flood rising from, say, one cubit Aswân to six cubits, where there are many dry sandbanks, and the spreading out of the river is considerable, and there is an absence of overlapping

[1] "Monumental Egypt," chapter i.

flushes from behind, the rate goes up to fifteen days. There is a very great difference in time and rate between Green and Red Nile. The rise is 45 ft. at Aswân, 38 at Thebes, and 25 at Cairo.

From the data obtained at the gauges named which have been kindly forwarded to me by Mr. Garstin, the U.S. of State of the Public Works Department of Egypt, I have ascertained that the average time taken by the flood to travel now between Thebes and Memphis is about nine days. Although the river bed is now higher than formerly, the land around Thebes, according to Budge, having been raised about nine feet in the last 1700 years, still the same elevation has taken place at Memphis, so that no difference in the velocity of the stream would be produced by this cause.

The great difficulty experienced in understanding the statements generally made concerning the Nile-rise arises from the fact that the maximum flood is as a rule registered in Cairo upwards of 40 days after the maximum of Aswân.

For the following account of how this is brought about I am indebted to the kindness of Col. Ross, R.E. :—

"The behaviour of the flood at the Aswân gauge is as follows: Between August 20 and 30 a good average gauge of 16 cubits is often reached, and between August 27 and September 3 there is often a drop of about 30 centimetres. The August rise is supposed to be mostly due to the Blue Nile and Atbara River. Between September 1 and 8 the irrigation officers generally look for a maximum flood-gauge of the year at Aswân. This is supposed to be the first flush of the White Nile. In the middle of September there are generally two small flushes, but the last twenty days of September are generally distinctly lower than that of the first week. The final flush of the Nile is seldom later than the 21st to 25th September.

"All this water does not merely go down the Nile; it floods the different basins. The opening of these basins begins from the south to the north. This operation is generally performed between the 29th September and the 22nd October. The great Central Egypt basins are not connected with the Nile for purposes of discharge into the river between Asyût and near Wasta, or a distance of 395–90 kilometres = 305 kil.

"The country in the middle or Central Egypt is broad, and thus there is an enormous quantity of water poured out of these basins into the lower reaches of the river about the 20th October, which seriously raises the Nile at Cairo, and in a good average year will bring the Cairo gauge (at Rodah) up to the maximum of the year on or about October 22, and hence it is that the guide books say the Nile is at its highest in the end of October.

"A gauge of 16½ cubits at Aswân while the basins are being filled does not give more than 21 cubits at Rodah (Cairo), but as the basins with a 16½ gauge will fill by the 10th September, it follows that a 16½ to 16 cubit gauge at Aswân will not give a constant Cairo gauge, as the great mass of water passes by the basins and reaches Cairo. Hence we have frequently the paradox of a steady or falling gauge at Aswân showing a steady rise at Cairo.

"If the gauge at Aswân keeps above 16 cubits to near the end of September, the basin-emptying is much retarded, as the emptying at each successive basin fills the Nile above the 16 cubit level; *hence the lower halves of the chains of basins do not flow off*, and thus when the great Middle Egypt basins are discharged, they do not raise the Nile so much as they do when the last half of September Nile is below 16 at Aswân.

"In years like 1887 and 1892, which differ from each other only in date of maximum gauge at Aswân, the river, having filled the basins in 15 to 20 days instead of in 25 to 30 days, comes down to Cairo in so largely increased a volume that a really dangerous gauge of 25 cubits at Cairo is maintained for over a fortnight (the average October gauge in Cairo is about 23 cubits), and from September 10 to October 25 the river remains from 24 cubits to 25½ cubits, and the Middle Egypt basins discharge so slowly that the opening day is hardly traceable on the Cairo gauge.

"In the 1878 flood, which was the most disastrous flood possible, the river rose in the most abnormal fashion, and on October 3 attained 18 cubits at Aswân. This breached the Delta, and in addition so delayed the Upper Egypt basins emptying from the reason before given that the wheat was sown too late, and got badly scorched by the hot winds of March and April."[1]

J. NORMAN LOCKYER.

THE LANDSLIP AT SANDGATE.

THE causes of landslips are in general so well known and the localities which are liable to them so clearly defined on geological principles that when on Monday, March 6, the public were startled by the news of a landslip at Sandgate, the probability would be that geologists who knew the district would be by no means surprised, more particularly as the locality of the catastrophe is in the midst of a typical section shown in many of the text-books, and the town itself gives its name to a subdivision of the Cretaceous rocks.

The event, however, does not appear to have been expected, and since it has happened conjectures as to its cause have been numerous; but the true explanation has been wanting.

The series of rocks which, in descending order, form the country about Sandgate are the Folkestone beds, the Sandgate beds, the Hythe beds, and the Atherfield clay. Amongst these it is natural to look in the first instance for the presence of clays, as the probable origin of a landslip, though very loose sands have also been known to give way. The Folkestone beds are for the most part sand and they are bound together by bands of grit. Moreover, they are above the affected area. The Hythe beds are likewise characterised by bands of hard limestone, separated by calcareous sands. There are left the Atherfield clay, whose nature is indicated by its name, and the Sandgate beds.

The most recent description of these is that of W. Topley, F.R.S., in the *Comptes Rendus* of the Congrès Géologique International, 1888, in which they are briefly characterised (p. 257) as "*Argiles vertes et sables.*" The same writer's description of them in 1883 (quoted also by H. B. Woodward in 1887) is somewhat different, but in his "Geology of the Weald," 1875, they are said to consist of dark clayey sand and clay, the total thickness being given as 80 ft. In his more detailed description, however, Mr. F. G. H. Price divides these 80 ft. into four parts, the lowest 20 ft. being all "clayey beds" (Proc. Geol. Assoc., vol. iv. p. 554). In a still earlier account by Prof. Morris (*l.c.* vol. ii. p. 41) we have the following interesting statement:—"The dark-greenish sub-argillaceous sands, known as the Sandgate beds, rise on the shore at a short distance west of Folkestone. The low undercliff which skirts the shore from Folkestone nearly to Hythe owes its origin to the presence of these beds, which from their retention of water and slight coherency of structure have caused the frequent subsidence of the beds above."

It would appear, then, that there are two possible sources of the slipping—the Atherfield clay and the clayey bands of the Sandgate beds, and thus much was indicated at once by Mr. F. W. Rudler (*Daily Graphic*, March 8).

On a personal examination of the area the whole history of the subsidence becomes clear enough. At

[1] The modern Egyptians still hold to the old months for irrigation. 7 Tuba=January 15 is commencement of wheat irrigation; 30 Misra is the last safe date for sowing maize in the Delta; 1st Tut is the date of regulating the bridges=September 8 in Upper Egypt.

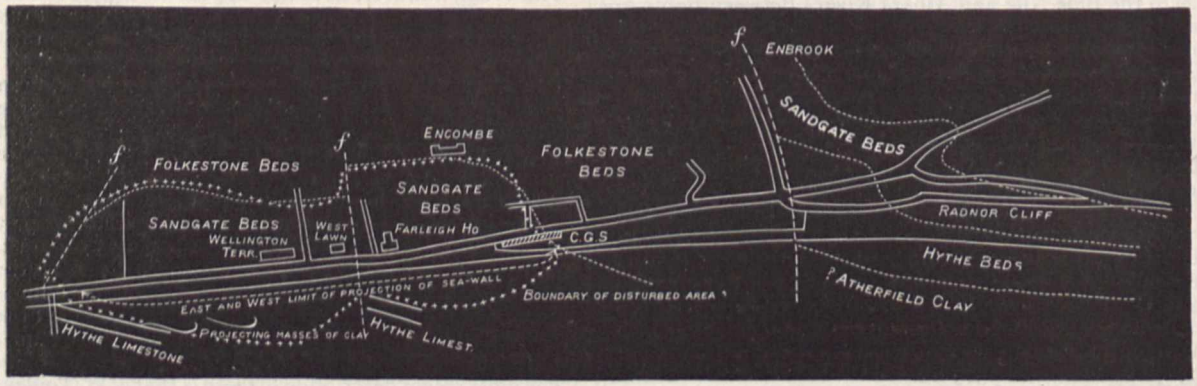
Sandgate itself neither the Atherfield clay nor the Sandgate beds are well exposed, but on the seashore between there and Folkestone we meet with the white-weathering massive limestone of the Hythe beds at Mill Point, and to the west of it. They are here dipping east at a moderate angle, and if this dip is continued, as the beds rise to the west, there would be room for the 60 feet of them which are seen at Hythe, between their probable outcrop in the lower part of the Enbrook Valley and low-water mark, opposite its debouchure. It must be here, if anywhere, that the recorded appearance of Atherfield clay occurs—for the state of things above described must here be terminated by a fault, as will be presently explained, and nowhere else along the coast till Sandgate is entirely passed can this clay occur within 40 yards seaward of low-water. On the east side of Enbrook, however, there is no landslip, and the actual landslip is thus shown to have nothing to do with the Atherfield clay.

Above the strong bands of Hythe limestone, however, west of Mill Point, are seen about 20 feet of soft, crumbling clay, occupying the base of the low cliff and becoming sandier above, as described by Mr. Price, and it is easily seen that the bottom of the Enbrook Valley is excavated in clay. The same clay is admirably seen on the other side of Sandgate, in the first cutting beyond Hythe Station on the branch line from Sandling Junction, so that though it is not now well exposed in Sandgate itself, we may be sure that it forms a continuous band immediately above the Hythe limestone.

Now, continuing to examine the coast below Sandgate on the west side of Enbrook we find an outcrop of Hythe limestone nearly opposite Farleigh House. Here also it has a dip towards the east; but it has also an abnormally high dip—perhaps 10°—inshore; such a dip in itself indicates a dislocation in the neighbourhood, but independently of this, the position of this band at the same level as that at Mill Point, while both bands dip, proves that there is a fault between the two, probably along the Enbrook Valley, with a downthrow on the west. This brings down the clay band at the base of the Sandgate beds to the sea level immediately to the east of the limestone above mentioned, and further on, to the east of the coastguard station, the sandy beds of the Folkestone series, which may, however, have slipped.

Going further west, we find the same band of Hythe limestone exposed on the sloping shore, having a similar easterly dip; but not so great an inshore dip, which, unless this were a lower band of Hythe limestone (which other observations negative), proves a second fault between these two, with a downthrow also to the west, but of smaller amount. Further west again, and just beyond the town, the sandy Folkestone beds are found at a lower level than they should be if the stratification were regular, and in the slight valley intervening there is a spring, which may indicate the line of another fault; or it may be that all this is only a surface slip; but, in any case, Folkestone beds occupy the actual surface.

The strike faults thus indicated are only what we might expect if the strata broke, as they so often do, during their upheaval. It is plain that such faults will rather complicate the surface exposure of the clayey rocks which overlie the Hythe limestone. Now, if we allow some 100 feet for the Sandgate beds, so as to include in the title all that portion of the series above the clay band at the base, which is not strengthened by the occurrence of indurated bands, and draw, from the purely geological considerations detailed above, the boundary of their surface exposure, which will not be an entirely simple one, *it exactly coincides with the boundary of the disturbed area.* Thus the upper boundary commences just beyond the town on the west, and runs very nearly along the line of the most westerly fault, till the latter has Folkestone beds on both sides of it; it then changes direction, and runs parallel to the outcrop of the Hythe beds on the foreshore, sloping down to a point above West Lawn, that is, to the probable position of the second fault; it is then thrown back along the probable line of that fault. It then again changes its direction and runs at first parallel to the second outcrop of the Hythe limestone, afterwards sloping down rapidly to the shore, so as to follow what would be probably the line of outcrop of the first hard band in the possibly slipped mass of the Folkestone beds. The conclusion from this seems inevitable. *The whole disturbance is due to a motion of soft Sandgate beds where they are unprotected by the overlying hard bands of the Folkestone beds.*



The nature of the motion can be determined by an examination of its upper, and particularly of its lower limit. The greatest amount of visible disturbance has taken place along the upper limit; here the ground is seen to have slipped downwards and forwards. This might be caused by the collapse of an underground hollow if such a thing were possible, but the loose sandy and clayey nature of the rocks would not admit of such a hollow being formed, and the thick clay band at the base would effectually shield the Hythe limestones from chemical erosion. The lower limit, however, shows very plainly that the motion has been a simple slip in a south-east or east-south-east direction. In the first place the westerly band of Hythe limestone on the foreshore which abuts against a concrete groin is absolutely unmoved, and the sea-wall above is quite intact (which is a second proof—if, after what has been said above, any further proof were needed, that the Atherfield clay has nothing whatever to do with the matter). In the second place, immediately to the east of this outcrop, the sea-wall has bulged forward by about three feet, as shown by the next, wooden, groin, and near low-water mark the overlying clay is seen

to be bulged up, so as to form a mound on the foreshore, which is being rapidly destroyed by the sea; while further east, opposite the end of Wellington Terrace, the overlying more sandy clays are also seen bulged up. Along the main road also, in front of West Lawn, on the western side of the supposed fault, the surface has been squeezed up. On the eastern side of this fault, further cracks, indicating a forward motion, are seen at the entrance to Encombe grounds; and, finally, the Coast Guard houses and the wall in front bulge forward at least three feet, and probably more, and the two sides of the street opposite have been squeezed together.

Thus the whole disturbance has been caused by the slipping downwards of the overlying soft beds over the inclined plane formed by the basement band of clay which rests on the Hythe limestone as a firm foundation, the direction of motion having been somewhat modified by the resisting mass of rock which lies to the east, and by the natural tendency of the sliding mass to take the shortest course to a lower level.

It is thus seen that the circumstances of the locality exactly fulfil the usual geological conditions for a landslip—*i.e.* a sloping bed of clay, which is liable to become slippery, and whose dip is towards the lower surface level where the overlying rocks find no support. Hence it may safely be said that any geologist, whose attention had been specially directed to the question, could have predicted that such an occurrence was extremely likely, sooner or later, to happen. There is, however, one necessary condition, which does not depend on the lie of the strata and the form of the ground, and that is that the clay should become slippery. This condition will probably account for the fact that in the area to the east of the Enbrook fault where all the other conditions are satisfied, *i.e.* in the neighbourhood of Radnor Cliff, no landslip has occurred. Clay is of course rendered slippery by the access of water. Now water will easily find its way through sandy strata, and there are sandy beds even in the lower portion till we come to the band of clay itself. As this is equally true in both localities the only difference can be in the amount of water.

Now there is a natural tendency for water to run down the dip slope of the strata, especially when there are hard bands as in the Folkestone beds, so that in this case most of the water will come from the west, and this source is cut off from the Radnor Cliff side by the Enbrook Valley, to the east of which there is little or no gathering ground; but to the west and north-west of the disturbed area there is a wide expanse of high ground, mostly rising 100 feet above the level of the Sandgate beds, and the water which falls on this finds its easiest outlet into these beds. They are therefore exactly in a position to get waterlogged, and that they are so is shown by the numerous springs that may be seen along the upper limit of the disturbed area.

The above considerations show that this area always has been and always will be liable to landslips. The lie of the beds which produces this liability cannot be altered by human agency, but the liability may be reduced to a minimum by a suitable system of drainage, which shall prevent the access of so large a body of water to so dangerous an area.

In the meantime the inhabitants of Sandgate may congratulate themselves that the shoreward dip of the beds and fault which breaks their continuity have reduced the result of the slip to a minimum, and rendered possible the remarkable circumstance that, though it happened in an area covered with houses, not a single house has been actually thrown down—not a single life lost.

As to the *immediate* cause of the occurrence, it is perhaps scarcely necessary to look for it. The landslip must necessarily have occurred at some time or another, and the conditions must for a long time have been gradually accumulating, by the constant access of water and the wearing action of the sea. If, however, the free discharge of the water from the beds has been in any way interfered with—by the stoppage of wells, or the construction of imperforate sea-walls—this would doubtless tend to the acceleration of the catastrophe; and an exceptionally wet season, like that we have recently experienced, might suffice to determine it. It would be scarcely necessary to add, except that the idea has been mentioned in the House, that the blowing up of the *Benvenue* and the *Calypso* could have absolutely nothing to do with it: in the first place, because the scene of the explosions was to the west of the disturbed area, and cut off from it by the massive Hythe beds, which are absolutely undisturbed—to say nothing of the Atherfield clay at sea which must necessarily intervene; secondly, because such a cause could not require several months to operate; and, lastly, because a vibration would rather tend to cause such beds to settle than to slip.

J. F. BLAKE.

NOTES.

PROF. VIRCHOW will deliver the Croonian Lecture this afternoon, and in the evening he will be entertained at the public dinner which is to be given in his honour at the Hôtel Métropole. It may at the same time be noted that an important scientific work, in three volumes, has just been issued by the Berlin publisher, August Hirschwald, in memory of the celebration of Prof. Virchow's seventieth birthday. The work is entitled "Internationale Beiträge zur Wissenschaftlichen Medicin," and among the contributors to it are Sir James Paget, Sir Joseph Lister, and other English writers.

A MOVEMENT has been started for the celebration of the hundredth anniversary of the birth of the illustrious Russian mathematician, Lobatcheffsky, who was described by the late Prof. Clifford as "the Copernicus of geometry." He was born on October 10, 1793. It is proposed that honour shall be done to his memory at the Imperial University of Kasan, with which he was for many years connected as a professor and as rector. The Physico-Mathematical Society of the University, which has taken the matter in hand, hopes to be able either to establish a prize with Lobatcheffsky's name for researches in mathematics, or to erect a bust of the great investigator in the University buildings. If the funds suffice, both of these things will be done. Subscriptions should be sent to the Physico-Mathematical Society, Kasan.

THE German Congress of Naturalists and Physicians, which was postponed last year on account of the outbreak of cholera, is to meet this year at Nürnberg.

PROF. W. C. ROBERTS-AUSTEN, F.R.S., chemist and assayer to the Royal Mint, and Mr. Thomas Bryant, President of the Royal College of Surgeons, have been elected members of the Athenæum Club, under the provisions of the rule by which the Committee is empowered to elect annually nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE half-yearly general meeting of the Scottish Meteorological Society was held at Edinburgh on Monday, March 13. The council of the society submitted its report, and the following papers were read:—On the temperatures of Lochs Lochy and Ness as affected by the wind, by Dr. Murray; mean temperature of London from 1763 to 1892, by Dr. Buchan; hygrometric researches at the Ben Nevis Observatories, by A. J. Herbertson.

WE understand that an enormous iron meteorite weighing nearly one ton (2044 lbs.) has just been received by Mr. J. R.

Gregory, of Charlotte Street, Fitzroy Square, from the same locality as the one described by him in NATURE in November last; it is 4 feet 2 inches long by 2 feet 3 inches wide and 20 inches thick. It comes from Youndegin in Western Australia.

THE secretary of the Physical Society asks us to say that in the report of the Society's annual general meeting (NATURE, March 2, p. 429) the name of Mr. J. T. Hurst was wrongly included in the list of members lost by death.

ATTENTION is called in the North Atlantic Pilot Chart to the fact that the great astronomical event of the month of April —the eclipse of the sun on April 16—will have certain features of special interest to the science of marine meteorology. Masters of vessels and observers who may be within the limits of the visibility of this eclipse are earnestly requested to make reports of their observations. The chart shows graphically the path of the total eclipse, the northern limit of visibility, and curves showing at what places the eclipse begins at 1 hour, 2 hours, and 3 hours, and when it ends at 3 hours, 4 hours, and 5 hours, Greenwich mean time, April 16. It is pointed out that there are observations which any one can make, and that these may prove to be of great interest and value. The following are particularly desired: (1) any changes in the clouds accompanying changes of temperature during the eclipse; (2) reading of the barometer every half hour from 11.30 to 5.30 G.M.T., while in the path of total eclipse; (3) temperature of the air, both wet and dry bulb, during the same interval; (4) any peculiar appearance of light during the eclipse; (5) the altitude and azimuth of any faint comet that may be detected during the eclipse.

THE weather during the latter part of last week was exceptionally fine over England, the daily maxima being frequently above 60°, and reaching 66° in the midland counties on Sunday, a temperature which is nearly 20° above the mean maximum for the time of year. The nights, however, were very cold, owing to the radiation under a clear sky; in some localities the readings on the grass were as low as 23° to 25°, and little, if any, above freezing in the shade. These conditions were occasioned by the distribution of atmospheric pressure, there being a well-defined anticyclone over the southern parts of England and over part of the continent. But in Scotland and Ireland the weather was much less settled; low-pressure areas lay off the north of Scotland, causing gales and occasional rainfall, while hail occurred at Wick on Friday. At the beginning of the present week the barometer fell decidedly, the anticyclone moved to the eastward, and the type of weather underwent a complete change, fog becoming prevalent at many places in the southern parts of the kingdom, and on Tuesday a new depression reached the north of Scotland, accompanied by rainy and unsettled weather generally. The official report for the week ending the 11th instant showed that bright sunshine was more prevalent than it has been for many weeks, and that it exceeded the average amount in all districts; also that there was a great deficiency in the amount of rainfall in all districts, except in the north of Scotland.

Das Wetter for February contains some particulars respecting the extraordinarily high barometer readings during January. At the commencement of that month the isobar between Lapland and Finland indicated the unusual height of 30·9 inches, which increased to 31·1 on the 3rd. On this day the centre of high pressure was in the vicinity of the White Sea, the reading at Archangel being 31·2 inches, and at Kargopol, on the Onega, 31·3 inches. Such high readings in those parts in winter are the more noteworthy, owing to the frequent passage of depressions over the north of Europe during that season. Subsequently the high pressure area shifted to Eastern Siberia, where high readings are more usual. On January 12 the pressure at Irkutsk exceeded 31·5 inches, and on the next day it reached 31·7. According to Dr. Hann, such a high reading had only been recorded once before, viz. on December 16, 1877, at Semipalatinsk. But on the morning of January 14, the reading at Irkutsk, reduced to sea level and corrected for gravity, attained the unprecedented height of 31·8 inches. So far as it is known this is the highest reading that has ever been recorded on the globe. These high pressures were also accompanied by very low temperatures. On January 14 the thermometer at Irkutsk fell to minus 51°·3, or about 40° below the mean for the time of year. In the north of Sweden the thermometer fell to minus 76°, or 38° below the freezing point of mercury.

SOME shocks of earthquake have lately been felt at Quetta. Two occurred on February 13 at 9.50 p.m., and another shock on the 14th at about 3 a.m. These shocks caused a considerable scare, and many people rushed out of doors, the condition of many houses in Quetta being anything but safe. The *Pioneer Mail* says that several houses have since fallen at Quetta, and a number of people have been injured, and two killed thereby.

DR. D. D. CUNNINGHAM is carrying on a series of microscopical investigations into the Indian potato blight. Elaborate experiments are also being made in the practical treatment of the crop and of diseased soils. The results, according to the *Pioneer Mail*, are expected to be important, and will be made public in due course.

IT appears from the Ceylon Census Report for 1891 that the bulk of the population of the island live by agriculture. The proportion of the agricultural class to the general population is in Ceylon 70·5; in India 64·09; in England and Wales 15·44. Next in order of number comes the industrial class, which includes something less than one-sixth, and after it the commercial class, holding one-twentieth. The *Ceylon Observer* notes as remarkable the fact that in the Southern Province there is a larger Sinhalese industrial population than in any other province—a result, it is supposed, attributable to the large number of people engaged in utilising the products of the cocoa-nut tree, with a certain number of workers in jewellery, tortoise-shell, &c.

TWO Akka girls, who were rescued from Arab capturers by Dr. Stuhlmann and his companions, have been brought to Europe, and will remain in Germany for some months. In the summer they will be taken back to Africa, where they will be placed in some mission house, or otherwise provided for. They are supposed to be between seventeen and twenty years of age. A correspondent of the *Daily News*, who saw them at Naples, says they are well proportioned, and as tall as a boy of eight years of age. Their behaviour is "infantile, wild, and shy, but without timidity." One of them was always cross, bending her head, and glaring from beneath frowning brows; while the other often laughed joyously, was pleased with bead bracelets and other trinkets given to her, and expressed by a queer sniff of her flat nose her appreciation of some chocolate bonbons. After making "a capital dinner on rice and meat," they greatly enjoyed the sunshine in a pretty garden, where they gradually grew more confident, and finally allowed themselves to be photographed arm-in-arm with the little son of their hostess. "The coquettish one shook with laughter, and seemed to guess that a process was going on flattering to her vanity, while the cross one still looked gloomy and suspicious. They showed neither wonder nor admiration of the people and things around them in the artistically furnished house and tasteful garden; their eyes, though large and lustrous, have less expression than the ugly eyes of a monkey." These interesting representatives of one of the pygmy races of the world are to be presented to various scientific societies in Berlin.

AN interesting address delivered by M. Paul Richer at the last meeting of the French Association for the Advancement of Science is printed in the current number of the *Revue Scientifique*. The subject is the relation of anatomy to art. M. Richer gives a lucid account of the canons of the human figure which have been adopted during various periods in the history of art, referring especially to those of the Greek sculptors Polycleitos and Lysippos and to those of Leonardo da Vinci, Albert Dürer, and Jean Cousin. He then shows that we now have materials for the establishment of a scientific type of the proportions of the human body, so far at least as the white race is concerned. This type is not, of course, to be reproduced in the works of artists; but M. Richer thinks it may be of real service to them as a guide in the appreciation of the proportions of the different models they have from time to time to study.

MR. A. C. MACDONALD contributes to the *Agricultural Journal* of Cape Colony a full and interesting account of what has been done to develop the dairy industry in Great Britain. Speaking of the same industry in Cape Colony, he says that it is there only in its infancy. This is largely due to the difficulty which farmers otherwise favourably circumstanced have had hitherto to contend with in the transport of their dairy products to market in good condition. Now, however, the extension and union of railways have more or less removed this difficulty, and many of the leading farmers, taking advantage of the facilities afforded by such extension and union, have greatly increased their butter production. In fact, within the last two years the increase in the manufacture of this commodity in the colony has been very large. Mr. Macdonald sees no reason why in districts such as Alexandria, Bathurst, Peddie, Victoria East, Fort Beaufort, Albany, Port Elizabeth, Uitenhage, and East London, where it has now become difficult to farm with small stock or grow grain profitably, dairying should not prove as great a success as it has done in the Australian colonies, which in some respects are not so favourably situated as Cape Colony, provided that the same means are used.

THE nucleus of a palæontological collection was formed at the Johns Hopkins University five years ago by Dr. W. B. Clark from the deposits of the Atlantic coastal plain. He was able to gather together a very large amount of material owing to the richness of the formations in fossils and their accessibility to the city of Baltimore; and since that time additions have been made each year by collection and by exchange with the National and State Surveys and educational institutions. We learn from the new number of the University's "Circulars" that there was a greater increase of the fossil collections during the past year than during any preceding one. This was accomplished mainly by exchange and purchase, although a considerable amount of material was collected in the field. Among the more notable additions was a collection sent in exchange by Mr. G. F. Harris, of the British Museum. This collection is very rich in tertiary fossils, illustrating many of the typical English localities. It contains hundreds of species from the Eocene, Oligocene, and Pliocene of England. Owing to the fact that the richest and finest collections of the Palæontological Museum of the University are from the American tertiary, these English tertiary fossils are said to be of the highest interest and usefulness to students of geology.

AN interesting paper on Artesian wells as a water supply for Philadelphia was lately read by Prof. O. C. S. Carter before the chemical section of the Franklin Institute. A long-continued drought caused much inconvenience at Philadelphia during the summer of 1892, so that the inhabitants would be likely to welcome any practicable suggestion for providing them with new supplies of fresh and wholesome water. Prof. Carter, after careful investigation, strongly recommends the use of artesian wells, the water of which, he says, would be of considerable quantity and excellent quality.

AN instrument for measuring densities of liquids, which for simplicity can hardly be surpassed, is described by A. Handl in the *Wiener Berichte*. It consists of two glass tubes joined by an indiarubber tube. One of them is 30 cm. long and about 1 cm. wide, and bears two marks scratched into the glass at a distance of 20 cm. This tube is immersed in the liquid to be examined up to the lower mark. Meanwhile the other tube is totally immersed in water. On pulling it out the liquids in both tubes rise until that in the first tube reaches the second mark. The height of the water-column, read off on a suitable scale, measures the density of the liquid.

MESSRS. SIMPKIN, MARSHALL AND CO have issued Miss Eleanor A. Ormerod's "Report of Observations of Injurious Insects and Common Farm Pests, during the Year 1892, with Methods of Prevention and Remedy." This is Miss Ormerod's sixteenth report. She notes that during 1892 most of the insect infestations commonly injurious to field crops and fruit were present to such an extent as to cause inquiry as to their nature and as to methods of prevention, but that for the most part they did not affect large districts to a serious extent.

A NEW scientific journal devoted to the interests of general systematic botany has made its appearance, published at Chambésy, near Geneva, under the title *Bulletin de l'Herbier Boissier*.

A BOTANICAL DICTIONARY, by Mr. A. A. Crozier, has just been published by Holt and Co., of New York, containing definitions of over 5000 words.

MESSRS. PERKEN, SON, AND RAYMENT have issued an illustrated catalogue of photographic apparatus, magic lanterns, and optical instruments.

MESSRS. WHITTAKER AND CO. will issue in their Specialists' Series a work on "The Dynamo," by C. C. Hawkins and F. Wallis, and a new edition of Sir David Salomons' work on "The Management of Accumulators." They have also in preparation in the Library of Popular Science an introductory work on "Electricity and Magnetism," by S. Bottone, and one on "Geology," by A. J. Jukes-Browne. Mr. Perren Maycock has completed the second part of his work on "Electric Lighting and Power Distribution," and it will be issued in a few days. An illustrated work on "British Locomotives," by C. J. Bowen Cooke, of the London and North-Western Railway, is in the press, and will probably be issued in May. Messrs. Whittaker have also in the press a new work by J. Horner ("A Foreman Pattern-Maker"), entitled "The Principles of Fitting," and the second part of Mr. Brodie's "Dissections Illustrated."

MESSRS. GRIFFIN AND CO. announce "A Manual of Dyeing," by Dr. Knecht, Mr. Chr. Rawson, and Dr. R. Loewenthal; "Oils, Fats, Waxes, and Allied Materials, and the Manufacture therefrom of Candles, Soaps and other Products," by Dr. C. R. Alder Wright; "Painters' Colours, Oils, and Varnishes, by Mr. Geo. H. Hurst; "Griffin's Electrical Price-Book," edited by Mr. H. J. Dowsing; the tenth annual issue of the "Year-Book of Learned and Scientific Societies;" "A Treatise on Ruptures," by Mr. J. F. C. Macready; "Forensic Medicine and Toxicology," by Prof. Dixon Mann; "The Medical Diseases of Children," by Mr. Bryan Donkin; "A Medical Handbook for the Use of Students," by Mr. R. S. Aitchison; "The Physiologist's Note-Book," by Dr. W. Hill; and "A Text-Book of Biology," by Prof. J. R. Ainsworth Davis.

MESSRS. L. REEVE AND CO. have in preparation a new work on the British Aculeate Hymenoptera from the pen of Mr.

Edward Saunders, uniform with the same author's work on the Hemiptera Heteroptera, just completed.

THE extreme difficulty which is experienced in the separate identification of the typhoid bacillus and the *B. coli communis* in consequence not only of their great resemblance microscopically, but also in the appearances to which they give rise when grown in artificial culture media, has caused much doubt to be cast upon the alleged detection of the former in water. It is well known that the *B. coli communis* is an almost constant attendant upon the typhoid bacillus, being normally present in the alimentary canal, and being, moreover, frequently found in large numbers in polluted streams and contaminated well-water. In nearly all cases, therefore, where a water is suspected of harbouring the typhoid bacillus the *B. coli communis* may also be expected to be present. Unfortunately, the many methods which have been devised, some of which are extremely ingenious, for separating out the typhoid bacillus from other organisms, are based upon the idea that few, if any, micro-organisms can flourish in as acid a medium as this bacillus, and no account has been taken of the refractory nature in this respect of the *B. coli communis*. This organism is, in fact, possessed of far greater powers of resistance than its more dangerous companion, and whilst the proportion of citric acid or phenol to be added, whether directly to the water or to the culture medium, is such that in some cases the other organisms present are destroyed whilst the typhoid bacillus and the *B. coli communis* are left untouched; in other methods the amount of acid prescribed is sufficient to entirely obliterate the typhoid bacillus, leaving, however, the *B. coli communis* sole master of the field. In an extremely interesting paper which has appeared in the *Zeitschrift für Hygiene*, vol. xii. p. 491, 1892 ("Ueber den Typhusbacillus und den *Bacillus coli communis*"), Dunbar discusses very fully all these points, and gives an account of the principal methods in vogue for the isolation of the typhoid bacillus, together with a critical commentary based upon his own experimental observations, as well as those of other investigators. As a result of these researches Dunbar maintains that no absolutely trustworthy method at present exists for the successful identification of the typhoid bacillus in the presence of the *B. coli communis*, and that it is highly probable that the latter has in many cases been mistaken for the former in water supposed to contain the typhoid bacillus. There can be no doubt, however, that, with a knowledge of these imperfections, the judicious application of some of these methods may very greatly facilitate the isolation of the typhoid bacillus in the presence of other organisms, and that, moreover, a method which is able to restrict the varieties present on any given gelatine plate to the *B. coli communis* and the typhoid bacillus already removes some of the chief obstacles.

A FURTHER communication from M. Moissan concerning the chemical properties of the diamond is contributed to the current number of the *Comptes Rendus*. In the first place precise determinations have been carried out of the temperatures at which various kinds of diamonds undergo combustion in pure oxygen. As the action of oxygen upon the diamond has so long been known, it appears somewhat singular that, as M. Moissan states, no exact data concerning the temperature of combustion should hitherto have been obtained. It will doubtless be remembered that Dumas and Stas, in their celebrated experiments in connection with their determination of the atomic weight of carbon, burnt diamonds in a current of oxygen in a porcelain tube heated in an ordinary earthenware table furnace. Other chemists have since performed similar experiments with the aid of the combustion furnaces employed in organic analysis. In order to be able to determine the temperature of such combustion with precision, M. Moissan has employed a modification of Le Chatelier's thermo-electric apparatus, placed along with the diamond in a wide porcelain tube closed at the ends with glass plates through which the combustion in oxygen could be viewed. It was found that when the temperature is slowly raised under these conditions the combustion proceeds gradually without the production of light. But if the temperature is raised 40° or 50° above the point at which this slow combustion commences, a sudden incandescence occurs, and the diamond becomes surrounded by a brilliant flame. Various deeply-coloured specimens of diamonds burnt with production of incandescence and flame at temperatures of 690°–720°, but transparent Brazilian diamonds did not attain the stage of slow combustion without incandescence till the temperature of 760°–770° was reached. A Cape diamond suffered gradual combustion at 780°–790°. Specimens of exceedingly hard boort likewise commenced to combine with oxygen at 790°, and burnt brilliantly at 840°–875°. When Cape diamonds were heated in a current of hydrogen to a temperature of 1200° they remained unchanged; but if the stones had previously been cut they frequently lost their brilliance and transparency. Dry chlorine gas was found incapable of reacting with the diamond until a temperature of 1100°–1200° was attained. Hydrofluoric acid vapour likewise only reacted at about the same high temperature. Vapour of sulphur also requires to be heated to 1000° before reacting, but in the case of black diamonds bisulphide of carbon is produced at about 900°. Metallic iron, at its melting point, combines with the diamond in a most energetic manner, and it is a point of considerable interest that crystals of graphite are deposited as the fused mass cools; hence the experiment forms a striking mode of converting the allotropic form of carbon which crystallises in the cubic system into that which crystallises in the hexagonal system. Melted platinum likewise combines with the diamond with great energy. A most curious reaction has been observed to occur between the diamond and the carbonates of potassium and sodium. When a diamond is placed in the fused carbonate contained in a platinum dish it rapidly disappears, and carbonic oxide is copiously evolved. Fused nitre or potassium chlorate, however, have not been observed to exert any action upon diamonds.

NOTES from the Marine Biological Station, Plymouth:—Recent captures include examples of the Hydroid *Myriothela phrygia*, the Opisthobranchs *Aplysia punctata* and *Oscanius membranaceus*, and the "cotton-spinner" (*Holothuria nigra*). The week has been marked by a rapid increase in the numbers of Echinoderm larvæ, especially of *Auricularia* and *Bipinnaria*, but *Plutei* are still relatively scarce. Ephyræ of *Aurelia* continue plentiful, and have grown appreciably. Among the Anthomedusæ, *Rathkea octopunctata*, *Sarsia prolifera* (without buds), and the gonozooid of *Podocoryne carnea* have been noticed; among Leptomedusæ, the *Eucopium-* and *Eucope-* stages of *Clytia Johnstoni* have made their appearance, together with *Thaumantias Forbesii* (Haeckel) and small *Obelia* medusæ. Several *Muggiæa* and a single *Pilidium* were seen on the 11th inst. The Nemertine *Amphiporus lactifloreus*, and the Anomoura *Eupagurus Prideauxii*, *Galathea dispersa* and *intermedia* have begun to breed.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. G. J. Sheppard; a Leopard (*Felis pardus*) from Kismaya, East Africa, presented by Mr. J. Ross Todd; a Spotted Ichneumon (*Herpestes nepalensis*) from Nepal, presented by Lieut. Philip Egerton, R.N.; six Vulturine Guinea Fowls (*Numida vulturina*) from East Africa, presented by Mr. R. J. Macallister; a Black Tanager (*Tachyphonus melaleucus*) from South America, presented by Miss Trelawny; a Greater Sulphur-crested Cockatoo (*Cacatua*

galerita) from Australia, presented by Miss Amy M. Dundas; three white-tailed Gnus (*Connochætes gnu*, ♂ ♀ ♀) from South Africa, deposited; a Burchell's Zebra (*Equus burchelli*, ♀), two Silver-backed Foxes (*Canis chama*), a Cape Bucephalus (*Bucephalus capensis*) from South Africa, a Salvin's Amazon (*Chrysotis salvini*) from South America, purchased; four Upland Geese (*Bernicla magellanica*) from the Falkland Islands, received in exchange; four Coypus (*Myopotamus coypus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (1892 III.).—This comet has now become rather a difficult object, but the following ephemeris may be useful for those employing large instruments:—

12*h*. *Paris Mean Time.*

1893.	R.A. (app.)			Decl. (app.)		
	h.	m.	s	°	′	″
March 16.....	2	55	29·0	+ 35	27	53
17.....		57	16·1		30	43
18.....	2	59	3·5		33	33
19.....	3	0	51·1		36	23
20.....		2	38·9		39	13
21.....		4	27·0		42	2
22.....		6	15·3		44	51
23.....	3	8	3·8	35	47	40

THE SIZES OF JUPITER'S SATELLITES.—M. J. J. Landerer describes in the *Comptes Rendus* some experiments made to test the accuracy attainable in measuring the diameters of satellites by their shadows cast on the primary. He took a finely-ground glass plate and blackened it, leaving a space in the middle representing the appearance of Jupiter with its bands and small black spots representing shadows. He then placed it at a distance of 314 m., illuminated it by a suitable light from behind, and sketched the disc through the telescope used for the actual observations. With some practice it was found possible to draw such spots correctly to within one-tenth per cent. M. Landerer then applied his method to the satellites themselves, and found the following numbers for their radii:—0·0199, 0·0184, 0·0435, and 0·0419. The number of observations was twenty-six for the first satellite, seventeen for the second, thirty for the third, and twenty-two for the fourth. The commonly accepted numbers, obtained by micrometric measurements of the bright satellites, are 0·0291, 0·0259, 0·0431, and 0·0367.

OBSERVATIONS OF THE ZODIACAL LIGHT.—In No. 3155 of the *Astronomischen Nachrichten* Mr. Arthur Searle gives an account of the experimental work he and Prof. Bailey have been carrying on with respect to the best methods of making and recording observations of the zodiacal light. Owing to the prevalent use of electric light in the neighbourhood of Harvard College Observatory, the observations were made at some distance away. The general mode of defining the position of the zodiacal light up to the present has been by drawing its outline on a star atlas exactly as it appeared in the sky at the time of observation. The great drawback about this method is that in the majority of cases the zodiacal light has no definite outline, but gradually decreases in brightness as one recedes from the axis of the figure, eventually fading imperceptibly away. That this is so is the general idea and is backed up by observations, but it is also true that the contour, so to speak, of the luminous figure is sometimes sharper at some places than at others. Instead of outline drawings these observers have substituted contour lines in which the degree of light represented by each contour is stated; the latter is accomplished by selecting a portion of the sky "unaffected by the zodiacal light, but of equal brightness with those portions traversed by the contour line." This region would naturally lie near the Milky Way and its situation is defined by the stars in the vicinity. To complete the record the geographical position of the observer's station and the time of observation should be included in the statement. In addition to the contour lines two other suggestions are put forward, (1) that the axis of brightness should be indicated by a line, and (2) that should there be distinctly observed by any chance two cones of light, an outer and an inner, such a distinction should be shown in the record by drawing a boundary between them.

WEINEK'S LUNAR ENLARGEMENTS.—Since the appearance of the magnificent enlargements obtained by Dr. Weinek from the Lick Observatory negatives, many details of surface structure have been brought to light which have up till now evaded even the aided eye. These details, consisting as they do of winding rills, valleys, and hair-like markings, appear quite sharp and distinct in contrast with the larger surface features, and it is this fact that has caused some uncertainty about their being actual features on the lunar surface. Every one acquainted a little with photography knows that a photograph loses in sharpness the more it is enlarged, and it is here very curious to find a picture after being twenty times enlarged with minute details quite crisp and sharp, and the larger portions quite fluffy, as is the case in the enlargement of Vendelinus, taken on August 31, 1890. As Mr. Elger remarks (*Observatory*, March), "if these curious markings represent actual features on the moon's surface, ought they not to be easily seen in any good telescope that shows the formation and its principal details with far greater sharpness than the twenty-times enlarged negative, and many small craters, &c., in addition which are scarcely traceable upon it? One does not understand why this should not be so, unless these objects make an impression on the sensitive plate that they fail to do on the retina, which is hardly likely to be the case." M. Faye, in *Comptes Rendus* (No. 9) for March, when referring to these enlargements, says that several members, MM. Fizeau, Mascart, and Cornu included, reserved their opinions on the interpretation of these markings, which seemed to be the results of retouching. "Certain vermiculées appearances," says he, "show a clearness which is strictly in contradiction with the very general 'estompée' appearance of the lunar cliché."

"L'ASTRONOMIE" FOR MARCH—The March number of this magazine commences with some observations of Jupiter made at the observatories in Juvisy, Bruxelles, and in Spain during the past year. The numerous drawings which accompany the observations impress one with the incessant change that is taking place in the dense atmosphere, while the large red spot was as usual seen ploughing its way apparently through one of the dark belts. The period of rotation of this spot seems to have suffered a retardation during the last twelve months, as will be seen from the following table, which we take the liberty of producing here:—

	h.	m.	s.		h.	m.	s.
1879 ...	9	55	35·7	1886 ...	9	55	40·1
80 ...			35·0	87 ...			40·1
81 ...			36·1	88 ...			40·2
82 ...			37·2	89 ...			40·3
83 ...			38·1	90 ...			41·5
84 ...			39·2	91 ...			42·2
85 ...			40·1	92 ...			39·3

M. Guillaume, of the Lyons Observatory, contributes some interesting notes on the appearances of Saturn's rings during the same year, at which time it will be remembered we were lying nearly in its plane. Besides the drawings showing the general features of the planet, there are some illustrating the different degrees of luminosity observed at various parts of the ring itself. "The Circulation of Winds at the Surface of the Globe" is the title of an article by M. A. Duponchel, in which he gives as an introduction a brief historical account of the early hypotheses; while M. Flammarion gives us the fifth chapter on "Comment Arrivera la fin du Monde," dwelling for the most part on the destructive forces at work on the earth's surface.

BERMERSIDE OBSERVATORY.—In the advertising sheets of the *Observatory* for March we are sorry to see the following notice:—"On sale (the owner giving up astronomical work) the 3-foot Common reflector, with or without dome, complete, in perfect order. Mirror by Sir H. Grubb. Full particulars on application to J. Gledhill, Bermerside Observatory, Halifax."

GEOGRAPHICAL NOTES.

A TELEGRAM from Port Stanley announces the return of the Dundee whaling ships to the Falkland Islands (see NATURE, p. 282) on their way home. In the two months during which they were absent it is improbable that high latitudes were reached, but it is evident that a cargo was rapidly obtained, although it is not reported whether the species of whale hoped for was found.

THE Geographical Studentship at Oxford lately held by Mr. Grundy has been awarded to Mr. W. H. Cozens-Hardy, New

College. Mr. Cozens-Hardy has already made some interesting journeys in Montenegro and the neighbouring little-known parts of the west coast of the Balkan Peninsula which he intends to study further.

THE expedition of M. Delcommune by Lake Tanganyika appears to have been the most successful of all those sent out by the Katanga Company, as its leader has returned to Leopoldville, and will soon reach Europe to recount his experiences. The expeditions of Captain Stairs and Captain Bia, although successful in reaching their destination, were unfortunate in losing their leaders, and all the parties suffered terribly from sickness and famine. One of the interesting circumstances of these expeditions is the fact that a bronze tablet commemorating the death of Livingstone has been fixed to the tree at Old Chitambo's, where the great traveller died. This tablet was sent out in duplicate by Mr. A. L. Bruce of Edinburgh, son-in-law of Dr. Livingstone, through Mr. Arnot, who being unable to reach Chitambo's himself, entrusted one of the tablets to Captain Bia, by whose party it was placed in position.

MR. MACKINDER'S educational lectures, of which the eighth was delivered in the hall of the University of London on Friday night, continue to be well attended. The subject of the lecture was the Alps as a factor in European history, and the series of fine maps specially prepared for projection by the lantern enabled the development of the historical argument to be followed from point to point.

THE March number of the *Scottish Geographical Magazine* contains a valuable note by Prof. Mohn on the climate of Greenland, in which he epitomises his discussion of Dr. Nansen's results, published in a recent Ergänzungsheft of *Petermann's Mitteilungen*, and corrects it by the record of Peary's work. The isotherms (reduced to sea-level) run parallel to the coast, the interior being coldest at all seasons; 30° F. compared with 26° on the coast for January, 30° as compared with 50° for July, and on the average for the year the centre of the land is probably about −10°, while the coast has the temperature of 30°.

THE CHATHAM ISLANDS AND AN ANTARCTIC CONTINENT.

At the last meeting of the Royal Geographical Society Mr. H. O. Forbes discussed the question of the former extension of an Antarctic continent in relation to certain observations made during a recent visit to the Chatham Islands. The whole surface of these islands, especially Wharekauri and Rangiauria, is covered with a bed of peat in places over forty feet in depth—deeper in the northern part than in the southern—traversable in safety only by those acquainted with the country; for to the inexperienced eye there seems in most places no difference in the surface which can carry with safety both horse and rider, and that on which the lightest-footed pedestrian cannot venture without being engulfed. The surface of some of the larger and wetter depressions in the ground was covered with a brilliant-coloured carpet of luxuriant mosses, emitting an aromatic fragrance, spread out in artless undesigned parterres of rich commingled green, yellow, and purple, and endless shades of these, warning the traveller of the existence of dangerous bogs beneath, and brightening miles of treeless moorland, which, but for those floating gardens, would be uninviting and uninteresting. In many places all over the island this great peat-moss is on fire, and has for years been smouldering underground, or burning in the exposed faces of the great pits which have now been burnt out. Dr. Dieffenbach mentions these fires at his visit in 1840, and states that the combustion had begun before 1834. They appear to have been burning in one part or another of the island ever since Dieffenbach's visit. A peculiarity in the main island that strikes the visitor very early is the occurrence of many lakes and tarns. These lakes are, for the most part, on the eastern side, at the back of the low hills facing Petre Bay. The largest is fifteen miles long, over forty miles in circumference, and about ten and a half miles broad at its widest part.

Mr. Forbes's object in visiting the islands was to look for the remains of a fossil bird, fragments of which had been sent to him in New Zealand. These he discovered in considerable numbers, and found that the bird was no other than a species of *Aphanapteryx*, a large and remarkable member of the rail family, which lived contemporary with the celebrated dodo in the Island of Mauritius, and was very similar to one of the extinct flightless birds of that island. Here was the only place in the world where it was known to exist, and where it had with the dodo preserved its fading race down to about two hundred years ago, when both of them passed away and perished for ever from among living things. In the Chatham Islands the remains of the *Aphanapteryx* were found in kitchen middens of the Morioris, showing that in this region of the world also it had survived down to comparatively recent date, just as the moa had in New Zealand.

In the Chatham Islands there still live several types of flightless birds scarcely represented elsewhere, except in widely separated oceanic islands. To account for their distribution it is necessary to reason backwards to former distributions of land and sea. The occurrence of similar forms in the three southern continents and in the islands which lie between them is most easily explained by a former Austral continent of considerable northern extension. The outlines of this continent it is of course impossible to trace with anything approaching to accuracy till we are in possession of a larger number of soundings. But it is not unlikely that the great meridional masses of land—or world ridges—which are probably of primeval antiquity extended to meet prolongations northward of the Antarctic continent. There is some evidence that the direct union of South Africa with the other continents was not for so prolonged a period as the others. The presence of the *Aphanapteryx* and other ocydromine birds both in the Mascarene and in the New Zealand continental Islands supports other evidence pointing to an extension of that area south by Marion and Kerguelen Islands, and of New Zealand south, or of the Antarctic land north, by way of the Macquarrie, Auckland, and Antipodes Islands. It is interesting to observe that the great Pacific trough to the east of the longitude of New Zealand extends far south into the Antarctic region.

It is not necessary to suppose that all the southerly extending arms were connected contemporaneously with an Antarctic continent. It is impossible to account for the presence, for instance, of some South American forms in Australia and not in New Zealand; of Mascarene forms in the New Zealand region and not in Australia, or in Africa, or elsewhere, while we are unacquainted with the orography, the rivers and mountain barriers, of the submerged southern continent; and its various commissures may have been open at one time and closed at another. As there are, moreover, abundant evidences of great volcanic action over all the region, in New Zealand, South America, Mascarenia, and the Antarctic Islands, the permutations and combinations of the ups and downs of these lands, the openings and closings of the gates, paths, or stepping-stones, are beyond our computation.

The deductions as to an Antarctic continent, made on biological grounds, are supported by the depth of the circumpolar sea, so far as it is known. The submarine plateau of the Austral land slopes northward all round the shores of the known lands more gently than is the case along any other coast, and this would seem to indicate that, if elevated, the land would form in great extent a continuation of the three primal ridges of the globe southward, coalesced and spread out round the Pole, with, between these arms, the terminations of the great and permanent ocean troughs. How far these hypotheses—which are but a restatement, in great measure, of the investigations and conclusions of many distinguished naturalists, geologists, and geographers may be substantiated or refuted by future discoveries it is difficult to say; but the discovery of these interesting *Aphanapteryx* bones on the Chatham Islands must always remain an important factor in the solution of this question.

There was an animated discussion.

ARCHÆOLOGICAL WORK IN AMERICA.

IN his report, just issued, on the Peabody Museum of American Archæology and Ethnology, Prof. Putnam is able to record the results of a very exceptional amount of useful work. This is due to the fact that while the officers of the Museum have discharged their usual duties many special archæological and ethnological researches have also been carried on with a view to the collection of material for the Chicago Exhibition. Prof. Putnam says:—

Never before has such an extensive field of anthropological research been covered in two years' time, and it is desirable to place on record what has been accomplished. In the north,

Lieutenant Peary's expedition to Greenland has brought back a valuable collection from the little known tribe of Eskimo at Whale Sound, including their summer houses of skins, their boats, sledges, weapons, implements, utensils, ornaments; full sets of garments and carvings in ivory, as well as several hundred photographs of individuals of the tribe and of scenes illustrating their daily life; also several crania, and a complete census of the tribe with a full set of anthropometrical measurements and observations. In Labrador, the Skiles expedition (upon which I obtained positions for two Harvard students, one as a naturalist and the other as astronomer) has brought back 57 of the Labrador Eskimo,—men, women, and children with all their belongings,—making an Eskimo village now on the Fair grounds in Chicago, where it will remain until the Fair is over. On the Pacific side Dr. Sheldon Jackson has made ethnological collections in Alaska, and also among the coast tribes of Siberia. Mr. Cherry has collected from the tribes of Yucon valley; and by seven other assistants a systematic collection has been made on the north-west coast, between the Columbia River and Alaska, particularly from northern Vancouver and the Queen Charlotte Islands. On the Saskatchawan Mr. Cowie has made a complete collection to illustrate the life and customs of the tribes of the valley.

Arrangements have been made with the Canadian Commissioner of Indian affairs by which the interior tribes of Canada will be represented living on the Fair grounds; and by the cooperation of the Canadian Government World's Fair Commission a representation of the archæology of Canada has been secured. In the eastern portion of Canada Mr. Tisdale and Mr. Fenollosa, both Harvard students, have collected anthropological data, and much of ethnological importance. Nearly all the Indian tribes of the United States have been visited by students from Harvard and other universities for the purpose of obtaining anthropological data relating to the physical characteristic of the various tribes and of collecting ethnological material. . . .

The State of New York through its World's Fair Commission has also been brought into this work. The Commissioners are earnestly cooperating with me in securing a large archæological collection, and also a thorough representation of the Iroquis tribes. Families from these tribes will be living on the Exposition grounds in bark houses such as were in use when this powerful nation first came in contact with our race.

South of the United States, the Bureau of Latin-American Republics in connection with the State Department has been working with the Ethnological Department of the Exposition, of which its forms a section, and a number of officers of the army and navy were detailed to visit the various republics and arouse an interest in the Exposition, and also to make collections in ethnology and archæology under instructions which I furnished for their guidance. These gentlemen have accomplished much ethnological importance, and have secured several collections from the native peoples of Central and South America. Mr. Frederic Ober was sent to the West Indies and made a special research among the Caribs.

In relation to Mexican archæology, Mrs. Zelia Nuttal, acting in her double capacity as honorary assistant in the Museum and in the Ethnological Department of the Exposition, has been engaged in a search for objects in Europe, brought there at the time of the Spanish conquest, and has found several interesting things, connected with the period of Cortez, of which she has had facsimiles made both for the Exposition and for the Museum.

Further South in Mexico, Consul E. H. Thompson has continued the work in connection with his explorations for the Museum among the ancient ruins of Yucatan. During this time he has made about 10,000 square feet of moulds of portions of the ruined buildings, showing the façades, parts of corners of structures, doorways, and the great recess with its pointed arch of the so-named "House of the Governor" at Uxmal. He has also moulded both sides of the famous Portal at Labna. Casts are to be made from these moulds in Chicago, and there will be seen on the Exposition grounds facsimiles of these elaborately carved stone structures of Yucatan, over and around which will be the tropical plants native to the region of the ruins. As this work by Mr. Thompson was in connection with his explorations for the museum, we can secure such casts from the moulds as we may desire at the cost of making the casts, which, however, will be several thousand dollars.

The Museum Expedition to Honduras, which is an important part of the work of the year, will be specially mentioned further on, but as it forms a link in the chain of explorations it is referred to in this geographical review. Farther south, Mr. G. A. Dorsey, a graduate student in this department of the University, working as a special assistant for the Exposition, has made extensive and important explorations on the Island of La Plata, Ecuador, and in Peru and Bolivia, where he collected a large amount of material. Lieutenants Safford and Welles have secured series of garments, weapons, and other objects illustrating the tribes of portions of the interior of South America. Other officers sent out by the Latin-American Bureau have been farther south, and Patagonia and Tierra del Fuego have been drawn upon for representations of their ethnology.

Returning to the United States, archæological work has been carried on in Ohio by Dr. Metz, Mr. Saville, Mr. Moorhead, Mr. H. I. Smith and Mr. Allan Cook. In the Delaware valley, Mr. Ernest Volk, who in previous years was in the field with me, has been engaged in making a careful exploration of several ancient village sites, burial places, and workshops or quarries, where stone implements were made. Mr. Allan Cook of the University also made a brief study of a small burial-place on Cape Cod. Mr. M. H. Saville, a student assistant in the Museum, examined an ancient soapstone quarry in Connecticut from which interesting specimens were obtained both for the Museum and Exposition; and several gentlemen, particularly Dr. F. H. Williams, Mr. Wm. C. Richards and Mr. James Shepard, who showed him much courtesy, gave to the Museum a number of stone implements found on and near the old quarry. In Maine, Mr. C. C. Willoughby working entirely for the Museum, explored two singular burial-places in the Androscoggin valley in which the graves were so old that the skeletons had entirely disappeared, leaving in the graves only masses of red ochre and numerous implements and other objects of stone. This exploration was conducted in a careful manner and the notes, drawings, and photographs of the objects in place show how thoroughly the work was done. A fine lot of implements in perfect condition was found by Mr. Willoughby, and several others obtained in former years from the same place were given to the Museum by Mr. Elijah Emerson of Bucksport. This remarkable collection will be exhibited in Chicago as part of the Peabody Museum exhibit and will afterwards be arranged in the Museum. At the request of Mr. T. H. B. Pierce of Dexter, Me., Mr. Willoughby also made a partial examination of a mound near Dexter which may be a burial mound. Further exploration should be made, for if it prove to be a burial mound it would be the only one known in New England.

Important researches in physical anthropology have also been carried on. These were in part based on the observations made by the assistants among the native tribes, and in part upon collections. In this connection Dr. Franz Boas, aided by Dr. G. M. West and two clerical assistants, has been engaged in the museum in classifying the anthropological data and in preparing charts, tables, and diagrams to illustrate this subject at the Exposition. Thus for the first time there is being prepared a presentation of the physical characteristics of the native American peoples. Measurements have also been taken, and observations made, on more than fifty thousand children in the public schools in different parts of the United States and Canada, as well as on those in the Indian schools, and on many negro children. In this connection we have secured the cooperation of the authorities of the Japanese schools, and of those of the Hawaiian Islands. We shall thus have the measurements of a number of Japanese and Kanaka children for comparison. To this series of physical measurements has been added a series of tests relating to the mental development of children. These observations and deductions will not only furnish data of importance to educators, but there is reason to believe, from what has already been accomplished in this direction, that they will also give the basis upon which decided reforms in certain directions will be established. It is almost needless to say that the details of this part of the work are entrusted to Dr. Franz Boas, who is my earnest collaborator in connection with the Exposition.

This brief review of the work of about 100 assistants shows how much has been done during the year; and as the Peabody Museum is the place from which it has all been directed, and as much of the work has been done by my regular assistants and students, it is eminently proper to refer to it in this report as showing the relation of the Museum to anthropological research in America. It must also be remembered that the directors of the World's Columbian Exposition have not only given to me this grand opportunity for research, but that it has been largely paid for by the funds subscribed by the citizens of Chicago. Never before has there been a year when so much money has

been expended for pure research in anthropology under one direction as during the past year; and praise and honour are due to the business men forming the directory of the Exposition in Chicago, who have so cordially met my proposals and furnished the means for carrying them out on so grand a scale. Notwithstanding the vast material interests involved in the Columbian Exposition, it must be admitted that Chicago has nobly supported pure science in this connection and has shown an appreciation of its high aims.

On the Honduras Expedition Prof. Putnam reports as follows:—

It was stated in the last report that an expedition had just started to make the preliminary explorations for the ancient ruins of Copan, and in that report is given a brief outline of the origin and plans of this undertaking on the part of the Museum to be carried on by the assistance of patrons of archæological research. It is indeed a pleasurable duty to announce that the first season's work of the expedition has proved a decided success; and that although the party had many trials and difficulties to overcome, no serious accidents or sickness occurred. Messrs. Saville and Owens returned in safety, in May last, bringing with them a large number of most interesting and important objects illustrating the wonderful carvings in stone; several vessels and many fragments of pottery; numerous ornaments made of stone, shells and bone; stone implements; and portions of human skeletons. Among the latter are several incisor teeth, each of which contains a small piece of green stone, presumbly jadeite, set in a cavity drilled on the front surface of the tooth. We had before received from very ancient graves in Yucatan human teeth filed in a peculiar manner, and now we have teeth from the ancient graves in Copan ornamented in another way. This is of particular interest in adding one more to the several facts pointing to Asiatic arts and customs as the origin of those of the early peoples of Central America. A most striking resemblance to Asiatic art is noticed in several of the heads carved in stone,—one in particular, if seen in any collection and not labelled as to its origin, would probably pass almost unchallenged as from Southern Asia. These may prove to be simply coincidences of expression of peoples of corresponding mental development brought about by corresponding natural surroundings and conditions. At present we must admit that there are many resemblances in architecture, sculpture, ornament, and religious symbolism, between Central America and portions of Asia. The true meaning of these resemblances will be made known as authentic materials for study are obtained by such thorough and exhaustive field work as the Museum has been carrying on; and none is so important for this special subject as that of the Honduras expedition. For this work, however, a large sum of money is required. The ten years allowed for the work in Honduras by the edict of that government must be utilised to the fullest extent; and each year must find the Museum ready to put its party in the field well equipped and provided with money for the very expensive work to be performed.

It is not my intention to give an abstract of the results of last year's explorations at Copan. It is far better that the report should be carefully prepared by those engaged in the actual field work from year to year. After sufficient information has been obtained about the ruins themselves, and the architectural and chronological relationship of the various structures; and after a thorough knowledge of the different modes of burial has been acquired, and all possible objects have been collected, then conclusions can be drawn which will be of scientific value, since they will be based on a thorough knowledge of all the facts. An important beginning was made by the expedition last year, plans of the plaza and of the principal structures forming the great mass of the ruins having been made, many photographs taken, and paper moulds of important sculptures, lines of hieroglyphs and several of the large idols or carved monoliths secured. Considering the difficulties of transportation (wholly by mules to the coast—a seven days' journey), both Messrs. Saville and Owens, and all associated with them must be congratulated on what they accomplished. Since the return of the expedition the photographs have been printed, preliminary reports have been prepared, and casts have been made from the moulds. These casts are now being placed in the Museum, and a series has also been made for the Boston Art Museum, and another for the Columbian Exposition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. Liveing announces a course of demonstrations in spectroscopic chemistry, to be given during the first three weeks of the Easter term, daily (except on Saturdays) at 11, beginning on April 24.

The examination in Sanitary Science for the Diploma in Public Health will be held from April 4 to April 8.

The honorary degree of Doctor in Science will be conferred on Prof. Virchow, at a special congregation on Tuesday, March 21.

A grant of £65 has been made from the Worts Travelling Scholars' Fund to H. Woods, of St. John's College, for the purpose of palæontological research in Saxony and Bohemia.

Lawrence Crawford, B.A., Fifth Wrangler, 1890, has been elected to a Fellowship at King's College.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 16.—"The Value of the Mechanical Equivalent of Heat, deduced from some Experiments performed with the view of establishing the Relation between the Electrical and Mechanical Units, together with an Investigation into the Capacity for Heat of Water at different Temperatures." By E. H. Griffiths, M.A., Assistant Lecturer, Sidney Sussex College, Cambridge, assisted by G. M. Clark, B.A., Sidney Sussex College, Cambridge. Communicated by R. T. Glazebrook, F.R.S.

If a calorimeter is suspended in a chamber, the walls of which are maintained at a constant temperature, we can, by observations over a *small* range across that outside temperature, deduce the rate of rise due to the mechanical work done in the calorimeter, when the supply of heat is derived from stirring only. By repeating the observations in a similar manner over ranges whose mean temperature θ_1 differs from that of the surrounding walls θ_0, we obtain the change in temperature due to the combined effects of the stirring, radiation, conduction, and convection at all points of our whole range of temperature. As the success of the method depends (1) on the possibility of maintaining the exterior temperature unchanged, and (2) on the regularity of the supply of heat due to the stirring, we briefly indicate our method of securing those conditions.

1. The calorimeter[1] was suspended within an air-tight steel chamber. The walls and floor of this chamber were double, and the space between them filled with mercury. The whole structure was placed in a tank containing about 20 gallons of water, and was supported in such a manner that there were about 3 inches of water both above and beneath it. The mercury was connected by a tube with a gas regulator of a novel form, which controlled the supply of gas to a large number of jets. Above those jets was placed a flat silver tube, through which tap water was continually flowing into the tank, all parts of which were maintained at an equal temperature by the rapid rotation of a large screw. Thus, the calorimeter may be regarded as suspended within a chamber placed in the bulb of a huge thermometer—the mercury in that bulb weighing 70 lbs. A change of 1° C. in the temperature of the tank water caused the mercury in the tubes of the regulating apparatus to rise about 300 mm. Special arrangements were made by which it was possible to set the apparatus so that the walls surrounding the calorimeter could be maintained for any length of time at any required temperature, from that of the tap water (in summer about 13° C. in winter 3° C.) up to 40° C. or 50° C. We know by observation that the temperature of the steel chamber (when once adjusted) did not vary by 1/500° C., and we believe the variations were much less.

2. We experienced great difficulty in devising a suitable form of stirrer; and we attribute the failure of our earlier experiments to defects in the ordinary forms. We find it impossible, without a lengthy description, to give a clear idea of the stirrer ultimately adopted. We can only state here that it was completely immersed when the depth of the water exceeded 1 cm., that

[1] The calorimeter was of cylindrical form, and suspended by three glass tubes. It was made of "gilding metal," which both internally and externally was covered with a considerable thickness of gold. All metal surfaces within the calorimeter were thickly gilded.

its bearings were outside the steel chamber, and that the water was thrown from the bottom to the lid of the calorimeter.

More than 100 experiments were performed (many of them lasting several hours) in order to determine the value of $\sigma + \rho(\theta_1 - \theta_0)$,[1] when the calorimeter contained different masses of water. The harmony amongst the results was satisfactory.

The pressure in the space between the calorimeter and the walls of the steel chamber was reduced, as a rule, to between 0·3 and 1·0 mm.[2]

The absolute value of the loss by radiation, &c., at different pressures was ascertained, and it was found that the rate of gain or loss decreased very rapidly when the pressure was reduced below 0·5 mm.

If $\left(\frac{\delta\theta_1}{\delta t}\right)_{\sigma,\rho}$ is the rate of rise due to the non-electrical supply, and $\left(\frac{\delta\theta_1}{\delta t}\right)$ that due to the electrical supply, then

$$\frac{\delta\theta_1}{\delta t} = \left(\frac{\delta\theta_1}{\delta t}\right)_e + \left(\frac{\delta\theta_1}{\delta t}\right)_{\sigma,\rho} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

We have indicated the manner in which we determined the last term of this equation, and thus, by direct observation of $\frac{\delta\theta_1}{\delta t}$, we were able to obtain the value of $\left(\frac{\delta\theta_1}{\delta t}\right)_e$ and

$$\left(\frac{\delta\theta_1}{\delta t}\right)_e = \frac{E^2}{J.R'.M'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where R′ is the resistance of the coil, and M′ the capacity for heat of the calorimeter and its contents at a temperature θ_1.

Throughout the experiments E was kept constant, the arrangement for maintaining the ends of the coil at a constant potential difference worked admirably, and it is probable that in no case did the variations exceed 1/10,000 of the mean potential difference during each experiment.

The value of R was determined by a direct comparison (conducted by Mr. Glazebrook) with the B. A. standards and values of R were expressed in true ohms as defined in the B. A. Report, 1892.

The difference between the temperature of the coil and that of the surrounding water was ascertained, and the resulting difference of resistance was found to be such that $\delta R = \cdot 00422n^2$, where n was the number of Clark cells by which the potential difference at the end of the coil was maintained.

The mercury thermometers were standardised by direct comparison with several platinum thermometers, and a further comparison has (through the kindness of Dr. Guillaume) been made with the Paris hydrogen standard. The difference obtained by the two methods in the value of the range is only ·005° C.

The various quantities in equation (2) having been determined (with the exception of J and M′), we can deduce from equation (2) the time (T) of rising 1° C at any point of our range when R = 1 ω and E is the potential difference of one Clark cell at 15° C.

We thus get

$$\frac{J}{E^2} M' = T \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If w be the weight of water, and w_x the water equivalent of the calorimeter at the standard temperature, and if f and g be the temperature coefficients of their specific heats, then

$$M' = w(1 + f\overline{\theta_1 - \theta}) + w_x(1 + g\overline{\theta_1 - \theta});$$

hence

$$\frac{J}{E^2}\{w(1 + f\overline{\theta_1 - \theta}) + w_x(1 + g\overline{\theta_1 - \theta})\} = T \quad . \quad . \quad (4)$$

By repeating observations with different weights of water, w_1 and w_2, and observing T_1 and T_2, the corresponding times, we obtain by subtraction

$$\frac{J}{E^2}(w_2 - w_1)(1 + f\overline{\theta_1 - \theta}) = T_1 - T_2 \quad . \quad . \quad . \quad (5)$$

Hence when $\theta_1 = \theta$ (*i.e.* at the standard temperature) we can find J without first ascertaining the values of f, g, or the water equivalent of the calorimeter, and by repeating the observations over different ranges we can find f without previously obtaining J; or, having obtained f, we can find w_x and g, and then by equation (4) deduce the value of J from a single experiment. We have adopted both methods as a check upon the calculations, which involve much arithmetic. The latter method is the more convenient, as it enables us to ascertain the results of separate experiments, but it cannot be applied until the values of f, g, and w_x have previously been obtained by observations on two different weights at two different temperatures.

We give the values of T at 15°, 20°, and 25° C.

TABLE XLI.—VALUES OF T AT 15°, 20°, AND 25° C.

Temp.	Series I.		Series II.		
	Group B. $w = 188{\cdot}065$.	Group E. $w = 277{\cdot}931$.	Group A. $w = 139{\cdot}776$.	Group C. $w = 199{\cdot}674$.	Group D. $w = 259{\cdot}500$.
15·000	557·14	740·46	458·87	580·95	702·91
20	557·62	740·60	459·35	581·25	703·05
25	558·09	740·75	459·81	581·55	703·20
No of col. } 1	2	3	4	5	6

From this table we obtain the following results:—

Specific heat of water at 25° in terms of water at 15°, deduced from columns 4 and 6	= 0·99734
Ditto from columns 4 and 5	= 0·99722
Ditto from columns 5 and 6	= 0·99746
Mean	= 0·99734

Hence, adopting 15° C. as the standard temperature, the

SPECIFIC HEAT OF WATER $= 1 - 0{\cdot}000266\,(t - 15)$.[1]

Also by means of equation (15) we get the following values of J:—

Columns 4 and 6	J = $4{\cdot}1939 \times 10^7$
,, 4 ,, 5	J = $4{\cdot}1940 \times 10^7$
,, 5 ,, 6	J = $4{\cdot}1940 \times 10^7$
Mean	J = $4{\cdot}1940 \times 10^7$

This value of J, as previously pointed out (equation 5), is entirely *independent of the value assigned to the water equivalent of the calorimeter*.

And we find the water equivalent of the calorimeter at 15° C. in terms of water at 15° C. = 85·340 grams. The water equivalent of the calorimeter at 25° C. in terms of water at 15° C. = 86·174 grams.

Hence water equivalent $= 85{\cdot}340\{1 + 0{\cdot}000977(t - 15)\}$.

We can now find the capacity for heat of the calorimeter and contents for any weight of water at 15°, 20°, and 25° C., and deduce the value of J from each group separately.

TABLE XLIII.—VALUES OF J.

Group.	15°	20°	25°	Mean.
A	$4{\cdot}1940 \times 10^7$	$4{\cdot}1940 \times 10^7$	$4{\cdot}1939 \times 10^7$	4·1940
B	4·1930 ,,	4·1941 ,,	4·1949 ,,	4·1940
C	4·1939 ,,	4·1938 ,,	4·1937 ,,	3·1938
D	4·1940 ,,	4·1939 ,,	4·1940 ,,	4·1940
E	4·1938 ,,	4·1940 ,,	4·1943 ,,	4·1940
				4·1940

We have in the above table given the values resulting from the calculation at different temperatures, for the limit of our experimental errors is thus clearly indicated, since the values of

[1] σ = rise in temperature per 1 second due to the stirring. ρ = gain or loss in temperature per 1 second due to radiation, &c., when $\theta_1 - \theta_0 = 1°$ C.

[2] The pressures were ascertained by a McLeod's gauge.

[1] Over the range 14° to 26° C.

J ought (in the absence of experimental errors) to be identical at all temperatures. The close agreement between the values from different groups, and from the same group at different temperatures, is a satisfactory proof of the accuracy of our determination of the water equivalents of the calorimeter, and of the changes in it and in the capacity for heat of the water.

Hence, if we assume

1. The unit of resistance as defined in the "B.A. Report," 1892;

2. That the E.M.F. of the Cavendish Standard Clark cell at 15° C. = 1·4342 volts;[1]

3. That the thermal unit = quantity of heat required to raise 1 gram of water through 1° C. at 15° C.,

the most probable value of

$$J = 4{\cdot}1940 \times 10^{7}.$$[2]

This, by reduction, gives the following:—

J = 427·45 kilogramme-metres in latitude of Greenwich (g = 981·17).

J = 1402·2 foot-pounds per thermal unit C in latitude of Greenwich (g = 32·195).

J = 778·99 foot-pounds per thermal unit F in latitude of Greenwich (g = 32·195).

The length of this abstract is already unduly great, and we will, therefore, not enter on any discussion of the results beyond remarking that if we express Rowland's value of J in terms of our thermal unit we exceed his value by 1 part in 930, and we exceed the mean of Joule's determination by 1 part in 350.[3]

The difference between Rowland's value of the temperature coefficient of the specific heat of water and ours would, however, cause both his and our values of J to be identical if expressed in terms of athermal unit at 11·5° C.

March 2.—"The Effects of Mechanical Stress on the Electrical Resistance of Metals." By James H. Gray, M.A., B.Sc., and James B. Henderson, B.Sc., International Exhibition Scholars, Glasgow University. Communicated by Lord Kelvin, P.R.S.

This investigation was begun for the purpose of obtaining an easily worked method of testing the effect of any mechanical treatment on the density and specific resistance of metals.

For alteration of density, copper, lead, and manganese copper wires were tested. The effect of stretching was always to diminish the density, the alteration being small however: for copper about ½ per cent., and for lead ⅛ per cent. The effect of drawing through holes in a steel plate was somewhat greater, showing at first an increase of 2 per cent.; and, when the drawing was continued, the density began to diminish till, after drawing from diameter 2 mm. to 1·3 mm., it showed an increase on its original value of $\frac{9}{10}$ per cent. Several other interesting results on alteration of density were obtained.

The most important part of the investigation, however, relates to the alteration of specific resistance of copper, iron, and steel wire due to stretching; and, in connection with this, the authors wish particularly to emphasise the advantages to be gained from using the unit of specific resistance introduced by Weber, who always defined it in weight measure, that is, as the resistance of a length of the metal numerically equal to its density and section unity.

The conclusions arrived at are that for practical purposes any mechanical treatment, however severe, does not affect the electrical properties of the metals tested. As contrasted with this, it is interesting to note that the smallest impurity in the metal produces a greater change than the most severe mechanical treatment. For example, an impurity of ⅛ per cent. lowers the electrical conductivity by 13·5 per cent., while an impurity of ⅛ per cent. lowers it as much as 30 per cent.

"A New Hypothesis concerning Vision." By John Berry Haycraft, M.D., D.Sc. Communicated by E. A. Schäfer, F.R.S.

The author pointed out that when a blue pigment is mixed with its complementary pigment—orange-yellow—it makes a grey, not a green as is generally stated. This can be shown by the use of transparent colours, such as watery solutions of the aniline dyes. When you mix an opaque oil blue with its complementary orange-yellew and get a green it is because the light only passes through a very thin superficial film of the mixture, and a paint which is orange-yellow in the mass is only a pale yellow in a thin film, and transmits the green spectral rays stopped by the orange-yellow. In this case, therefore, the thin film of paint which alone affects the light is not a mixture of blue and its complementary orange-yellow, but only a mixture of blue and pale yellow.

In the case of Maxwell's colour discs you get a grey if the blue and yellow are complementary, or a green or red if they are not, just as in the case of mixtures of transparent pigments. Complementary pigments are simply those which between them absorb all spectral rays; thus blue absorbs red, yellow, and some green, and the complementary orange-yellow absorbs violet, blue, and some green. A mixture of these pigments on the palette—if transparent enough—or on the Maxwell's disc absorbs, therefore, the light which falls upon it from all parts of the spectrum in about equal proportions. If examined by the spectroscope the mixture of pigments and the rotating disc both give a dim, unbroken spectrum identical with that of white paper held in half light. In our study of vision we have to deal with the stimulus—spectral rays—and the resulting sensations. Inasmuch as the stimulus—the light of a dim, unbroken spectrum—is the same whether the eye looks at a mixture of blue and orange yellow on a palette, at a Maxwell's disc, or again at a piece of white paper held in half light, the resulting sensation must in all cases be the same—we call it grey or white. In the case of the rotating Maxwell's disc experiment we are not dealing with the fusion of blue and orange-yellow sensations, but the adding together of two halves of the spectrum to make a whole one. Once understood, the physiologist will discard the experiment altogether, as it has no bearing upon colour vision.

The work of Sprengel, Darwin, and especially of Sir John Lubbock, shows that the colour sense has gradually been evolved by the coloured environment of the species. We may infer that in the ancestral condition in which light was distinguished from darkness, but blue was undistinguishable say from red, all visual stimuli were felt as white or various shades of grey. The greater the amount of spectral light the nearer the sensation approached white. This, if accepted, explains why the outer and less used parts of the retina are colour blind in the human eye at the present day, and further explains why a minimal stimulus from a coloured object gives rise to a sensation grey. Just as we may smell something, but require to "sniff," in order to make out what it is, so the coloured object held far away may give rise only to the primitive sensation grey, and has to be brought nearer in order that its colour quality can be felt.

We may explain the fact that an artificial mixture of spectral green and red gives rise to the sensation yellow by the fact that all coloured objects which send to the eye red and green rays also send the intermediate yellow; these objects give rise to the sensation yellow, and we call them by that name. Inasmuch as this association of red and green rays has in the evolution of the eye always combined with yellow rays to produce the sensation yellow, we can explain, as an instance of association, the fact that artificially combined red and green rays produce a yellow sensation.

When, say, red and blue-green spectral rays are artificially combined, they produce a grey sensation, and this we can explain by the fact that no fully coloured natural object sends to the eye such a combination, which combination, therefore, played no part in the evolution of the colour sense, and it produces merely a primitive sensation of simple brightness—white or grey.

That a coloured object brightly illuminated appears white follows the law of maximal stimulation, for in this case the object absorbs so slight a proportion of the light from any one part of the spectrum that that part gives rise to its maximal effect, and the rest of the spectrum can do no more. In this case, therefore, the eye is affected equally (maximally) by all parts of the spectrum, and we have of course the sensation of white.

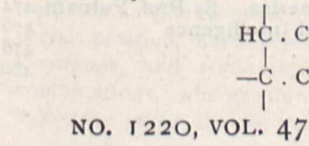
The above view is an attempt to explain some of the facts of vision by showing that they are on all fours with other facts known to the physiologist. This seems to the author a more scientific method than the one adopted by Young and Helmholtz, who "conceive" a visual apparatus, and endow it with such properties as will, in their opinion, account for the facts of visual sensation.

[1] If we assume the E.M.F. of our Clark cells to be the same as that of the Cavendish standard (and we are inclined to think we have over-estimated the difference), we get $J = 4{\cdot}1930 \times 10^{7}$.

[2] The value obtained by us in 1891 = (4·192 +) × 10^{7}.

[3] Rowland obtained the mean value of Joule's determinations by assigning values to different experiments, and the above comparison refers to the numbers thus obtained. If, however, we attach equal weight to all Joule's results, as reduced by Rowland, the mean *exceeds* our value by 1 in 4280, assuming our expression for the temperature coefficient of the specific heat of water.

Chemical Society, February 16.—Prof. A. Crum Brown, F.R.S., President, in the chair.—It was announced that the following changes in the Council were proposed by the Council for the ensuing year:—President, Prof. H. E. Armstrong, vice Prof. Crum Brown. Vice-Presidents: Dr. E. Atkinson and Mr. C. O'Sullivan, vice Prof. Hartley and Mr. Warington. Secretary, Prof. Dunstan, vice Prof. Armstrong. Ordinary Members of the Council: Messrs. C. F. Cross, Bernard Dyer, Lazarus Fletcher, and W. A. Shenstone, vice Mr. H. Bassett, Prof. Ferguson, Mr. J. Heron, and Mr. S. U. Pickering.—The following papers were read: Note on the preparation of platinous chloride, and on the interaction of chlorine and mercury, by W. A. Shenstone and C. R. Beck. The authors find that very pure specimens of chlorine may be prepared by igniting platinous chloride obtained by heating hydrogen platinichloride in a current of dry hydrogen chloride. On passing the dry gas for fifteen hours over the platinichloride at the boiling point of mercury and igniting the residue *in vacuo*, chlorine was obtained which contained 99·84 per cent. of the gas. A portion of the platinous chloride obtained in this experiment was heated at 500° in a current of dry hydrogen chloride during many hours; on then igniting the residue, chlorine was evolved which when treated with mercury only left a residue of 0·06 per cent. unabsorbed. The platinous chloride made by the above method probably contain a little platinum, but as a source of chlorine, it seems to be superior to the product of more familiar processes. The second sample of chlorine mentioned above acted very sluggishly on mercury; this fact, considered in connection with the great purity of the gas, supports the authors' view that the activity of chlorine towards mercury is probably due to the presence of impurity in the former.—The action of phosphoric anhydride on fatty acids. Part III., by F. S. Kipping. In the present paper the author shows that caprylone $(C_7H_{15})_2CO$, nonylone $(C_8H_{17})_2CO$, and myristone $(C_{13}H_{27})_2CO$, can be readily prepared from the corresponding fatty acids by the action of phosphoric anhydride; a number of derivatives of these ketones are described. Mixed ketones of the general formula $R.CO.R'$ are produced when a mixture of two fatty acids is treated with phosphoric anhydride at a moderately high temperature; the mixed ketone is, however, accompanied by two simple ketones. Treatment with phosphoric anhydride would seem to be one of the simplest and most rapid methods by which the ketone $(C_nH_{2n+1})_2CO$ can be prepared from a fatty acid $C_nH_{2n}O_2$.—Regularities in the melting points of certain paraffinoid compounds of similar constitution, by F. S. Kipping. The author has prepared and characterised a number of hydroximes, secondary alcohols and ethereal salts derived from the fatty ketones $(C_nH_{2n+1})_2CO$ and draws attention to certain regularities observed on comparing the melting points of these compounds. The melting points of all ketones of the general formula $C_nH_{2n}O$ cannot be calculated by means of the formula given by Mills (*Phil. Mag.* 1884), inasmuch as isomeric ketones frequently melt at different temperatures.—Some relations between constitution and physical constants in the case of benzenoid amines, by W. R. Hodgkinson and L. Limpach. A study of the formyl and acetyl derivatives of certain homologues of aniline shows, (1) that the entry of alkyl groups into the nucleus affects the melting and boiling points in a regular manner; (2) that the conversion of formyl into acetyl also involves an alteration in physical properties in extent the same as that produced by introducing CH_3 into the nucleus in an ortho- or para-position relatively to the amido-group, and (3) that the same (or any?) alkyl group entering the nucleus in the meta-positions has no effect on melting or boiling point. Several numerical regularities are also apparent.—Electrolysis of sodic ethylic camphorate, by J. Walker. On electrolysis, sodium ethyl camphorate yields the ethyl salts of two new acids, viz. campholytic acid, $C_8H_{13}.COOH$, and camphotetic acid, $C_{16}H_{28}(COOH)_2$. The first of these is a monabasic, unsaturated acid boiling at 240–242°. It is lævo-rotatory, but gives a dextro-rotatory ethyl salt. Camphotetic acid is a colourless crystalline solid, melting at 132°; it behaves as a saturated, bibasic acid and forms well-characterised salts. Judging from the nature of the electrolysis and the behaviour of campholytic acid towards bromine, camphoric acid should contain the group



—The hydrates of hydrogen chloride, by S. U. Pickering. Determinations of the densities of aqueous solutions of hydrogen chloride show a strongly-marked break indicative of the presence of a trihydrate. The author has obtained this hydrate in the solid state by making a series of freezing-point determinations; it forms large, transparent crystals melting at −24°·9. The densities also indicate the existence of a change of curvature at a point corresponding to a hexhydrate; the freezing-point determinations afford no evidence for or against the existence of this substance, but the presence of a decahydrate was indicated. —A new base from *Corydalis cava*, by J. A. Dobbie and A. Lauder. By exhausting crude corydaline with hot water the authors have isolated a new alkaloid of the composition $C_{19}H_{25}NO_4$, which they term corytuberine; this alkaloid contains only two methoxy-groups, whilst corydaline contains four. A number of its salts are described. The authors also give some notes on yet another alkaloid, which they consider to be distinct from all the bases of *Corydalis cava* hitherto described.

February 20.—Lord Playfair, F.R.S., Vice-President, in the chair.—This being the anniversary of the death of Hermann Kopp, Prof. T. E. Thorpe delivered a memorial lecture entitled "The Life Work of Hermann Kopp."

PARIS.

Academy of Sciences, March 6.—M. Lœwy in the chair. —On a partial differential equation, by Émile Picard.—On the spectro-photographic method which makes it possible to obtain photographs of the chromosphere, faculæ, protuberances, &c., by M. J. Janssen. This method was outlined by M. Janssen as early as 1869, at the Exeter meeting of the British Association.—Analysis of the ashes of the diamond, by M. Henri Moissan. All the specimens of the carbonado and Cape diamond analysed contained iron, as shown by the potassium sulphocyanide reaction. This metal formed the larger portion of the ashes. Silicium also occurred regularly, and calcium very frequently. It will be remembered that this alkaline earthy metal was found by M. Daubrée in native iron from Ovifak.—On some new properties of the diamond, by M. Henri Moissan (see Notes).—The pancreas and the nervous centres controlling the glycemic function, by MM. A. Chauveau and M. Kaufmann. The inhibitory action exerted by the pancreas on the glycogenic function of the liver appears to be dependent upon an excito-secretory centre controlling the cells performing the internal secretion of the pancreas. This centre is situated in the encephalic portion of the spinal cord, and the inhibitory impulse acts through this centre upon an excito-secretory centre controlling the glycogenic activity of the liver. The removal of the pancreas eliminates this control, and renders an excessive activity of the liver more serious.—The fixation of torrents and the planting of the mountains, by M. Chambrelent. It has been calculated that in the last forty years France has suffered losses amounting to 700 million francs due to inundations in places where the mountains were not wooded sufficiently to check the ravages of mountain torrents after heavy rain. The Chamber has recently voted a sum of 2,600,000 frcs. for the planting of the mountains, and it is hoped that the work will be completed in twelve or fifteen years.—On the cause of the variations of terrestrial latitude, by M. Hugo Gylden.—On some new derivatives of phenolphtaleïn and fluoresceïn, by MM. A. Haller and A. Guyot.—On the diameters of Jupiter's satellites, by M. J. J. Landerer.—On a class of dynamical problems, by M. P. Staeckel.—On surfaces whose principal planes are equidistant from a fixed point, by M. Guichard.—On a theorem of M. Stieltjes, by M. Cahen.—On a partial differential equation of the second order, by M. J. Weingarten.—On the calculation of stability of ships, by M. E. Guyon.—On electric waves in wires, and electric force in the vicinity of a conductor, by M. Birkeland.—Oscillographs; new apparatus for the study of slow electric oscillations, by M. A. Blondel.—Photographic reproduction of gratings and micrometers engraved on glass, by M. Izarn. Ammonium bichromate in gelatine gives better results than either collodion or silver salts in gelatine. Copies of microscopic divided scales and gratings were obtained easily and with certainty, and reflection gratings were produced by employing silvered instead of plane glass.—Concerning the direct-reading stereo-collimator of M. de Place, by M. R. Arnoux.—On the industrial preparation of aluminium, by M. A. Ditte. The alkaline aluminates are decomposed by water, and even in the presence of an excess of alkali the introduction of a few crystals of aluminium hydrate into the solution suffices to prevent the establishment of equili-

brium and to effect the decomposition of the aluminate, the rapidity of the reaction being increased by well stirring. In the industrial process of obtaining aluminium from bauxite, these crystals are provided by adding to the sodium aluminate a little of the deposit obtained by treating it with a current of carbon dioxide in the cold, a deposit which consists of crystallised aluminium hydrate. The gelatinous hydrate has no such effect. The alumina precipitated is very pure. Substances such as silica and phosphoric acid, dissolved out of the bauxite by the caustic soda employed, remain in solution.—On the isomerism of the amido-benzoic acids, by M. Oechsner de Coninck.—On the dimorphism of the chloroplatinate of dimethylamine, by M. Le Bel.—On inuline and two new proximate bodies—pseudo-inuline and inulenine, by M. C. Tanret.—Absorbing action of cotton on dilute solutions of sublimate, by M. Léo Vignon.—Remarkable resistance of animals of the genus *Capra* against the effects of morphine, by M. L. Guinard.—Alterations of molecular tissue in the barbel due to the presence of myxosporidia and microbes, by M. P. Thélohan.—On the maxillary apparatus of the Eunicidæ, by M. Jules Bonnier.—On the perfume of orchids, by M. Eugène Mesnard.—Experimental researches on the mole and on the treatment of this disease, by M. Julien Constantin.—A disease of the endive, by M. Prillieux; remarks by M. Arm. Gautier.—On the morphology of the cellular nucleus in the Spyrogyras and the resulting phenomena in this plant, by M. Ch. Decagny.—Discovery of *Mastodon Borsoni* at Rousillon, by M. A. Donnezan.—On the use of soluble cartridges in oceanographic measurements and experiments, by M. J. Thoulet.—Temperatures observed in the winter of 1789 at Montbéliard, by M. Contejean.

BERLIN.

Physical Society, January 20.—Prof. Kundt, President, in the chair.—Dr. Haentzsch spoke on the potential equation, gave an historical account of researches bearing on it, and added a communication on the results of his own investigations. Prof. Planck explained the arrangement and principle of a truly-tuned harmonium, built on the system of C. Eitz, and bequeathed to the Physical Institute. The instrument includes four and a half octaves, and possesses special notes, arranged in several rows and distinguished by four different colours, for the fifths, the major and minor thirds, and the major and minor sixths. The pure intonation of the harmonium enables it to be used with far greater success than one which is "tempered," for demonstrating that our ear accommodates itself to concords which are not quite pure, and is influenced in its discrimination of concords by the recollection of tones heard previously. The instrument is not suited for concert purposes.

Physiological Society, February 3.—Prof. du Bois Reymond, President, in the chair.—Prof. Gad opened a discussion on the communication made by Prof. Behring at the last meeting of the Society (see NATURE, vol. xlvii. p. 336). The discussion turned chiefly on the applicability of the results of Prof. Behring's experiments to the treatment of tetanus in man. Dr. Wernicke exhibited diphtheritic cultures which had been kept for more than a year, and still developed rapidly in either agar, gelatine, or broth. He then demonstrated on dissected guinea-pigs the more important symptoms of diphtheritic infection, viz. œdema at the place of inoculation, hyperæmia of the liver, kidneys, and adrenals, serous exudations in the abdomen and thorax. He next exhibited some guinea-pigs which, after inoculation with the bacilli of diphtheria, had been treated with blood-serum from other animals immune to diphtheria and had been thereby cured. It was found that the longer the interval which elapsed after inoculation before the curative serum was administered, the greater was the dose of the serum required to effect a cure. He finally reported on experiments on dogs in which immunity and recovery after inoculation had been similarly attained.

Meteorological Society, February 7.—Prof. von Bezold, President, in the chair.—Dr. Schubert gave an account of recent researches on the influence of forests on the temperature and humidity of the air, with special reference to certain forests in Austria. So far only the experiments made in Podolia in a leafy forest on level ground have led to uniformly positive results. From these it appears that the forest lowers the mean temperature of the air, but only in so far that the temperature at 8 p.m. is much lower than that existing in the open country, that at 2 p.m. it is higher than in the open, and that the daily amplitude of variation is greater in the forest. The speaker had however found, from a careful perusal of the existing data, and from comparative determinations made in the forests near Eberswalde, that the results so far obtained are markedly affected by radiation. The true temperatures of the air inside and outside the forest have not yet been measured, and for this purpose it would be necessary to use an aspiration-thermometer. Determinations of humidity are similarly adversely affected by wind and by evaporation due to air-currents. In this case accurate results would be obtained by means of an aspiration-psychrometer. Prof. Sprung communicated an observation he had made at the Potsdam meteorological institute on the recent coldest day in January. While endeavouring to find the most suitable position for a thermometer, he observed, while using similar aspiration-thermometers, the following simultaneous temperatures at four different places, viz. $-23°$, $-23°$, $-18°$, and $-17°$. The four places were: (1) in an adjoining meadow two metres above the ground; (2) at the north side of the observatory two metres above the ground; (3) two metres above the platform of the tower; and (4) at the cage of the anemometer seven metres above the platform. Hence the temperature at the comparatively slight elevation of the anemometer was 6° higher than at the ground, whereas usually the same four thermometers showed a slight fall of temperature at the greater elevation.

BOOKS RECEIVED.

L'Art de Chiffrer et Déchiffrer les Dépêches Secrètes: Marquis de Viaris (Paris, Gauthier Villars).—Traité Pratique de Calorimétrie Chimique: M. Berthelot (Paris, Gauthier-Villars).—The Poets and Nature: P. Robinson (Chatto and Windus).—The Evolution of Decorative Art: H. Balfour (Percival).—Discussion of the Precision of Measurements: S. W. Holman (K. Paul).—Report of Observations of Injurious Insects and Common Farm Pests during the Year 1892: E. A. Ormerod (Simpkin).—Some Lectures by the late Sir G. E. Paget, edited from MSS., with a Memoir by C. E. Paget (Cambridge, Macmillan and Bowes).—Catalogue of the British Echinoderms in the British Museum (Natural History): F. Jeffrey Bell (London).—Lehrbuch der Allgemeinen Chemie, 2 vols.: Dr. O. Ostwald (Leipzig, Engelmann).—The Mechanics of the Earth's Atmosphere: C. Abbe (Washington).—Das Horizontalpendel: Dr. E. von Rebeur-Paschwitz (Halle).—A Manual of Ethics: J. S. Mackenzie (Clive).—Notes on Astronomy: S. P. Johnston, edited by J. Lowe (J. Heywood).—L'Aquarium d'Eau Douce: H. Coupin (Paris, J. B. Baillière).—Les Lichens: A. Aclocque (Paris, J. B. Baillière).—Éléments de Paléontologie, première partie: F. Bernard (Paris, J. B. Baillière).—Der Nord-Ostsee Kanal: C. Beseke (Kiel, Lipsius and Tischer).—Catalogue of American Localities of Minerals: Prof. E. S. Dana (Gay and Bird).

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