THURSDAY, JUNE 14, 1888.

THE BOYS' "YARRELL."

An Illustrated Manual of British Birds. By Howard Saunders, F.L.S., F.Z.S. Part I., April 1888. (London: Gurney and Jackson.)

A BOYS' "Yarrell" is a book that many ornithologists have long wished to see. More than six years ago a scheme for producing one was thought out, and Mr. Howard Saunders was invited, and consented, to aid in its production. *Dîs aliter visum*—the scheme fell through for the time; but now the proposed coadjutor has been favoured by fortune, and has by himself been able to put it into operation. He is to be heartily congratulated accordingly, and not only he, but scores if not hundreds of boys—to whom the work, just begun, will afford no less delight than good instruction.

From the moment when the first part of the original edition of Yarrell's "British Birds" appeared—now more than fifty years ago—it was seen that a new era in the study had dawned. The author had no other scientific training than that which, amid the turmoil of business, he had been able to acquire for and by himself; but he knew the value of scientific work, and having an uncommon amount of common-sense, he knew that the introduction of too much of it into his books would render them indigestible to the unscientific public of those days. Hence his "British Fishes" and "British Birds," though intentionally popular, are permeated by an only half-concealed thread of scientific thought, which, without its interfering with their readableness, the true aspirant could catch, and guide himself thereby to a higher level. From the publishers' point of view, these works were successful beyond expectation; but they had one great drawback. They were abundantly illustrated, and therefore necessarily expensive. This put them, and especially the "British Birds," to which the theme of the present notice relates, out of the reach of almost all but those in easy circumstances. Scarcely a school-boy, however much he might covet a copy, such as he might happen to see in some more favoured hands, could out of his pocket-money afford to buy a "Yarrell"; and even though the price of the later editions has been somewhat reduced, there is not one of them that would be within his means. Moreover, they contained a good deal more than he cared to know. The sort of information he wanted was, let us say, whether the bird he saw on the top of a hedge was a Cirl-Bunting or not; or whether, as the gamekeeper had told him, the Sparrow-Hawk was "that artful to turn hisself" into a Cuckoo in the spring; or, again, whether the bird that had suddenly risen as he walked along the brook-side was a Summer-Snipe or a Sandpiper, and what was the difference, if any, between them. Of course he would also like to know how the Wild Duck got her ducklings down into the water from the hollow tree in which he had found her nest, and what became of the Swallows in winter, and the Fieldfares in summer. Yarrell's work gave all this in the best way possible, but it added a great deal more that the school-boy did not care a button for. It told him of "orders" and "genera," and gave "characters"—which to him were as hard as Greek verbs. Every now and then there was a bit of anatomy; but that was to the good, for your inquiring school-boy rather likes making a rough dissection, and is pleased to find that the windpipe of a drake differs from that of a duck. But then, again, there was a good deal of "distribution," and he was bored by recollections of dreary geographical lessons,[1] and was not interested at learning that such or such a bird was found in some country with a long name not easy to pronounce.

With all these merits and defects, Yarrell's work, in all its editions, undoubtedly held the field, and there grew up more than one imitation of it—specious, pretentious, and misleading. One of these plagiarisms has been "embellished" (that, at least, is the word used by the publisher) with coloured figures; but unfortunately, among people who knew no better, as well as among people who ought to have known better, they have met with a success hardly inferior to the work from which they have been ingeniously and shamelessly "cribbed." This shows the exceeding popularity of the subject; but it is disgusting to find in nearly every school-library one or more of these piratical works—generally instead of the good, though more costly, original, though sometimes on the same shelf with it, as if the two were of equal authority. The common excuse is the high price of the "Yarrell," but no excuse can justify the corruption of youthful minds by ignorance, twaddle, and inaccuracy. Better hunger than poison—if both be deadly, one will kill more quickly than the other; and, since while there is life there is hope, the chance of proper aliment being timeously supplied exists in the former case, but in the latter even the antidote, if such a thing there be, may be exhibited in vain.

The work now begun by Mr. Saunders ought to abolish for ever the excuse just spoken of. This "Manual of British Birds" is cheap, marvellously cheap, and as fully illustrated[2] as ordinary boys can wish. That the design he has followed is certain to have a good effect few in a position to give an opinion can doubt, and his treatment of it is satisfactory, considering the enormous difficulties in the way. When one thinks of the vast amount that has been written about British birds by men who have written from their own knowledge—leaving wholly aside the pilferers above complained of—it will be evident that no ordinary discrimination is needed to extract the essence and serve it up on an octavo page and a half, or perhaps a few lines more, for this is practically the amount of letterpress at Mr. Saunders's disposal, the top of the first page being reserved for a woodcut of the species. But Mr. Saunders has been a "Zoological Recorder," and therefore has learnt the art of "boiling down." Occasionally there is a tendency to "straggle"—a favourite word of his, and one that is seldom apposite—and if verbal criticism be allowable, a protest might be made against "segregate" (more than once used) where *separate* is meant. But generally Mr. Saunders sets an admirable example in the matter of language, and one that all ornithological writers might well follow, since some of the more profuse of them have lately banished grammar and etymology to the outer planets, while style is a quality unthought of.

[1] All the same, the school-boy of forty or fifty years ago did learn *some* geography—a kind of learning that has lately been almost wholly dropped.
[2] The illustrations consist mostly of reproductions of the well-known "Yarrell" woodcuts.

There is one drawback in a work of this kind, and to some extent it is perhaps unavoidable. Mr. Saunders, following literally the scheme originally laid before him, and disregarding the exceptions therein provided for, devotes two pages to each species of bird. Now it is evident that this Procrustean plan cuts off many details of the greatest interest from what might be said of some species, and compels the story of comparatively uninteresting species to be stretched out. Among these last must of course be reckoned those which have only a few times made their way to the British Islands, and have scarcely a claim to be called "British" birds. In a work like this, Mr. Saunders, with the justly-earned reputation he possesses, might well have taken a new departure; but, unfortunately, four out of the twenty species included in his first part come under this condemnation. Their room, where every line is precious, would have been better than their company, and their introduction gives the beginner a wholly mistaken notion of the British fauna. Figures of the same absolute dimensions are often useful for certain purposes of comparison; but to treat the Rock-Thrush and three exotic species of Wheatears on an equality with our real denizens, that have inhabited these islands longer probably than any human beings, is to present a piece of distorted perspective. The practice was excusable in old days, and those that had to tread the ancient tracks were compelled to follow it; but here was an opportunity of striking out a fresh line. Of course there is great difficulty in drawing that line, for it must be drawn arbitrarily, but an arbitary line would be better than none. On a wharf a post-and-rail fence, or a suspended chain, may be placed almost at random, and people may say that it should have been a few inches nearer to, or further from, the brink, but if it saves them from falling into the water, few persons will not recognize the service it does.

It is a pity that almost the first word in this excellent book is one to which exception must be taken. Mr. Saunders has brought back the vulgar name of "Missel-Thrush," which some people fondly hoped had been for ever abrogated—as being either a corrupt abbreviation or wholly without meaning. Of course he can cite Willughby and a long string of subsequent authorities in his favour; but the "*auctorum plurimorum*" principle is directly opposed to sound scientific sense; and if Mr. Saunders will look up Willughby's predecessors—Charleton and Merrett—he will find that they do not admit the solecism. In a work of this kind, which cannot fail to have a great effect upon the rising generation of ornithologists, the least tendency to return to exploded errors is to be deplored. So much for criticism of the part which is now before me: I gladly say of the whole book—*Floreat*. ALFRED NEWTON.

THEORY AND USE OF A PHYSICAL BALANCE.

Theory and Use of a Physical Balance. By James Walker, M.A., Demonstrator at the Clarendon Laboratory. (Oxford: Clarendon Press, 1887.)

THE author states that this publication was originally intended as a chapter of a book on practical physics for the use of students at the Clarendon Laboratory, but that he proposes to publish each chapter when ready, without waiting for the completion of the work. This method certainly has some advantages both from the author's and the student's points of view. The practical study of physics, like that of all other sciences, and perhaps even to a greater extent than any other, is rapidly becoming specialized, with the necessary consequences that while each subdivision is expanding and becoming weighted with more details and technicalities, many diligent workers on one part of the subject are indifferent to the methods and appliances used in other branches. The numerous army of students in electricity and magnetism may take, for example, but a very superficial interest in the experimental side of acoustics or optics. At the same time it may be open to question whether it is advisable to break a work up into comparatively small fragments, as appears to be the intention in the present case. Like all other matter, the subject may lose in cohesion by being presented in too fine a state of division.

The instalment now issued gives a detailed and precise description of one of Oertling's balances used in the Clarendon Laboratory. The very clear explanation of the mechanism is assisted by three plates, one a photograph showing a general view, and the others line drawings of the various parts. Any want of clearness and definition in the photograph, which is not a particularly happy example of a collotype, is amply atoned for in the sectional diagrams.

Details are given of the methods adopted by the manufacturers to insure the accurate adjustment of the knife-edges, to test for their parallelism, for their being in the same plane, for the equality of the lengths of the arms, and of the masses of the pans, &c. The expression for the sensibility of the balance is determined from the general equations of equilibrium, and practical instructions are given with the necessary formulæ for performing some half-dozen of the usual physical operations with the balance, such as the determination of density of bodies heavier and lighter than water, of bodies in small pieces, &c.

In a thorough and somewhat elaborate investigation, which seems hardly suitable for a work intended as a handbook for a student entering on a course of laboratory instruction, the writer discusses the equations of motion of a balance, and shows that the method of determining the position of equilibrium from the amplitude of the oscillations on either side of the zero is not rigidly correct, since the beam with its adjuncts have not a simple definite period of vibration like a pendulum. The reassuring result is, however, arrived at, that the errors introduced are of a vanishing order, if the masses in the pans remain constant during a set of weighings.

Borda's method of counterpoising to eliminate errors of the instrument is recommended according to the usual practice, a mass heavier than the substance to be weighed being placed in the left-hand pan, while the substance and known masses are placed in the right-hand pan to bring the beam into an observed position of equilibrium. This procedure has advantages over the more tedious and less cleanly plan of exactly counterbalancing the substance with shot and fine sand, &c.

In allowing for the supporting force of the atmosphere, the author assumes that the average amount of moisture in the air may be taken as two thirds of the maximum possible. This seems a very high value for a closed and artificially heated room; certainly much in excess for air in a balance case which contains any substance, such as chloride of calcium, for absorbing the moisture. Perhaps it is the uncertainty as to the condition of the air thus artificially treated which causes the author to omit any reference to any of the hygroscopic substances usually employed.

The standard masses used at the Clarendon Laboratory are stated to be marked with their apparent value in air at 10° C. and 76 cm. of mercury. It is the usual custom, we believe, to mark the absolute value of the masses. For work not requiring the most refined precautions, the convenience of weights marked with their apparent value is obvious: no correction need be made for the supporting force of the air on the weights; but if that accuracy is considered sufficient, it seems an unnecessary refinement to complicate the formulæ by introducing a correction for the difference between the temperature of the air and of the water in which the substance is weighed.

The work is very clearly written and admirably printed, and will doubtless form, when completed (and we hope this will not be at a distant date), a valuable addition to the text-books on this subject. We have only noticed two mistakes in the text—the omission of the small over-weight w at line 23, p. 12, and of the length of the arm, a, at line 10, p. 16; but neither of these omissions affects the final results. The average student would, however, probably prefer that a larger portion of the space should be devoted to the more practical side of the subject, to hints and precautions to be taken in various operations; those given are very good, but they might with advantage have been extended. It would also, we think, be useful to indicate by numerical examples the order of magnitude of the various corrections to be applied, so that a student may judge what corrections may be safely omitted in the particular observation on which he is engaged. Some of the space given to the description of the instrument might, we think, have been more profitably devoted to a general account of other types of construction. Only a passing reference is made to the "short-beam" balance, and other modifications of the physical balance are not alluded to.

THE FLORA OF WEST YORKSHIRE.

The Flora of West Yorkshire, with a Sketch of the Climatology and Lithology in connection therewith. By Frederic Arnold Lees. 8vo, pp. 843, with a Map. (London: Lovell Reeve and Co., 1888.)

IT is just a quarter of a century since John Gilbert Baker's excellent book on the botany, geology, climate, and physical geography of North Yorkshire appeared,[1] and the present volume, devoted to West Yorkshire, is avowedly moulded on that model. Since then, English county and other local "floras" have become very numerous—many of them well executed, others indifferently. We do not mean to say that Mr. Baker was the originator of local "floras," for this branch of botanical literature early took root in this country, and has perhaps attained a development unknown elsewhere. Interesting among the earlier of such publications is John Ray's "Catalogus Plantarum circa Cantabrigiam nascentium," which dates (1660) nearly a hundred years before the first edition of Linnæus's "Species Plantarum." It is interesting alike for its botany and its botanical history. But the importance of exactitude in recording the localities of plants was not thoroughly realized by amateur botanists until they were stimulated thereto by the methodical and conscientious, though somewhat discursive, phytogeographical writings of the late Hewett Cottrell Watson. Now, thanks to the exertions of the competent few, English amateur botanists are so thoroughly educated in geographical botany at the beginning of their studies, that the careless, or, what is worse, the unprincipled, recorder of assumed localities of the rarer plants, is at once discovered and exposed. The latitudinal and altitudinal range of each species is now known with such accuracy that any new record outside of the known limits is at once scrutinized and tested, and only accepted on the best authority. It is a question, however, whether this sort of thing is not being overdone.

Mr. Lees expresses a hope that the acknowledged adoption of Baker's admirable method of inquiry and statement will not be regarded as too servile. We think it will not; and had the imitation been carried a little further, and the briefer and more condensed style of the pattern followed, it would have been a distinct advantage, because it would have reduced the size of the book without in the least impairing its value. The area of West Yorkshire is about 2750 square miles, and this is divided into ten drainage districts, varying in size from 30 square miles (Mersey tributaries) to 570 square miles—Don with Dearne; and the stations, or a selection of stations, in which a given plant is known to occur in each of these districts are given—in many instances, in what we should regard as excessive detail. Whether it would not have been better to amalgamate some of the districts, instead of adhering so closely to a principle as to maintain a very small portion of a drainage area as a distinct district, we will not pretend to decide; but there is no doubt it would have resulted in a considerable saving of space, which might have been profitably devoted to a brief exposition of the total geographical area of each genus and species.

With regard to the manner in which Mr. Lees has executed the task he undertook, there is ample evidence that he has spared no pains; and we have means of knowing that those most concerned are very grateful for such a store of well-sifted records. Nevertheless, this work, which forms the second volume of the botanical series of the Transactions of the Yorkshire Naturalists' Union, has its peculiarities, chiefly of a literary kind. On opening the book, we happened to light on the "Foreword," first of all, and we naturally expected that our author was a purist who wrote only Saxon English; but we soon discovered that uncommon words, irrespective of their origin, are dragged into use, and sometimes so piled up as to obscure not a little the meaning of the somewhat inflated sentences. However, this peculiarity is not carried so far as to constitute a

[1] We understand that a new edition is in preparation.

serious defect in the work, and may be passed over with this allusion.

Very interesting are two introductory chapters on the climatology and lithology of West Yorkshire, specially in relation to plant-life, which many persons would doubtless gladly possess, apart from the enumeration of the plants of the region. In the list of pelophilous (clay-loving) plants, we note *Spiræa Filipendula*, a plant so strictly associated with chalk in the south of England, that we are surprised to find it among those characteristic of clay and mud-soils. Perhaps it was a slip of the pen for *S. Ulmaria?*

The total number of species of vascular plants enumerated is 1042, whereof 995 are phanerogams, which is equal to the whole phanerogamic flora of New Zealand, even after allowing 40 off for "critical species" of various genera. On the other hand, the vascular cryptogams of West Yorkshire are only 47 against 138 in New Zealand, of which 120 are ferns. Fortunately for the New Zealanders, and Australians too, for that matter, they are free from the "horse-tails," which are such terrible pests to farmers in some districts of this country; but seven species are indigenous in West Yorkshire.

Cellular cryptogams are also included in Lees's "Flora," and occupy about 250 pages. The enumerations of some of the groups are exceedingly imperfect —imperfect in consequence of their not having been investigated—and it would have been much more convenient for the majority of workers had this class been reserved for a separate volume. W. B. H.

OUR BOOK SHELF.

A Manual of Practical Assaying. By John Mitchell, F.C.S. Edited by William Crookes, F.R.S. Sixth Edition. (London: Longmans, Green, and Co., 1888.)

MITCHELL'S "Assaying" is so well known to all whom the subject concerns, that it is hardly necessary at present to do more than announce the appearance of a new edition. In this edition, as Mr. Crookes explains, much new matter has been introduced, and matter which had become obsolete has been omitted. Among the more important of the additions are descriptions of the "automatic sampling-machine," invented by Mr. D. W. Brunton; many new gas-furnaces and burners for the laboratory, devised by Mr. Fletcher, Messrs. J. J. Griffin, and others; new blow-pipe reagents and operations; new processes, dosimetric, volumetric, and calorimetric, for the partial and complete assay of iron ores, iron, steel, spiegeleisen, &c. In the copper assay the American system of fire assay is here, for the first time in this country, fully described. In the assay of silver, the action of bismuth on the ductility of this metal has received adequate attention. Much has been added about gold ores; and improved modes of assaying the precious metal and detecting it in poor ores are given. The number of woodcuts has been increased from 188 in the last edition to 201 in the present edition.

Asbestos, its Production and Use. By Robert H. Jones. (London: Crosby Lockwood and Son, 1888.)

THIS little book, written in epistolary style, though possessing little or no scientific value, contains an interesting account of the "asbestos" mines of Canada, and of the methods pursued in working the mineral in that country. It is precisely ten years since the first Canadian chrysotile mines were opened, and the annual yield at the present time appears to be more than 2000 tons, so that the new locality is rapidly becoming an important rival to the older and better-known asbestos mines of the Italian Alps. The author gives a brief description of the mode of occurrence of the mineral in the Serpentine belt which traverses the provinces of Megantic and Beauce in Quebec, and prophesies a wider development of this industry in the future; he does not, however, supply any such details as would suggest either the origin or the probable extent of the Canadian "asbestos," and the book contains no original observations of any scientific importance. The author does not appear to be aware of the difference between asbestos and chrysotile. The pages most interesting to general readers are those which contain an account of the latest uses to which the mineral is now applied; among which may be mentioned fire-balloons, theatre-curtains, fire-proof paint, filters, and letter-paper.

Industrial Instruction. By Robert Seidel. Translated by Margaret K. Smith. (Boston: D. C. Heath and Co., 1888.)

IN the years 1882 and 1884 industrial instruction formed the subject of much discussion in the Synod of the Canton of Zürich. Herr Seidel, who had long devoted earnest attention to the question, carefully answered all the objections to industrial education which were raised in the course of these debates; and the substance of his replies is embodied in the work translated in the present volume. If there is still anyone who has doubts as to the value of manual training in schools, he would profit largely by reading this little book. Herr Seidel's main point is that such training is absolutely essential in the interests of true education, and in working out this view he displays great intellectual resource and a thorough appreciation of the laws of mental growth. He is not afraid that when the need for this "new departure" is generally recognized the task imposed upon teachers will be beyond their capacities. "The training of teachers for industrial instruction," he says, "offers no difficulty, and will not (as has been asserted) by any means involve the necessity for two kinds of teachers. The teacher can very well master the new task, and if his prejudice has disappeared, will very gladly undertake it. Probably the imparting of industrial instruction will become a favourite employment of the teacher, because the change refreshes and the labour gladdens him."

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.*]

Electric Fishes in the River Uruguay.

IN Sir Horace Rumbold's "Great Silver River" (London, 1887), the author, when on the Upper Uruguay above Uruguayana, speaks of a "kind of Electric Eel (*Gymnotus*) called here *Rayo* or Lightning, of the effects of contact with which, very curious and unrelateable stories are told."

The range of the *Gymnoti* is usually supposed to be confined to the waters of the Orinoco and Amazons and their affluents, so that it would be very desirable to ascertain what this supposed electric fish of the Rio Uruguay really is. Perhaps some of your readers in the Argentine Republic may be able to assist us in solving this problem, which would be best done by the transmission of specimens of the fish in question to the British Museum. P. L. SCLATER.

3 Hanover Square, London, W., June 8.

The Salt Industry in the United States.

MR. WARD in his letter to NATURE (May 10, p. 29), respecting the salt industry in the United States, makes no mention of the important and numerous contributions to the literature of that subject by Dr. Charles A. Goessmann, at the present time Director of the Massachusetts Agricultural Experiment Station, but formerly, from 1861 to 1869, chemist to the Onondaga Salt Company, at Syracuse, N.Y. While filling that position he investigated very thoroughly the salt deposits of New York, Michigan, Goderich, Canada, and Petit Anse Island, Louisiana, and his published reports and memoirs (some twenty in number) upon the salines, brines, and mineral springs of the country form, for the period which they cover, a very complete and valuable record of the salt industry in the United States.

Amherst, Mass., May 26. F. TUCKERMAN.

Prof. Greenhill on "Kinematics and Dynamics."

MAY I ask space for a few short comments on Prof. Greenhill's letter in your issue of May 17 (p. 54), so far as it is directed against myself.

(1) The "circumlocutions" referred to are not of my devising, but are current phrases which involve no ambiguity and are useful for avoiding frequent repetition.

(2) It is not true that "although such words as 'a force equal to the weight of the mass of 10 pound weights' do not occur in Prof. MacGregor's book, they are strictly derived from his definitions." According to my definitions, it is the body itself which has weight, not its mass; and the above phrase is therefore meaningless.

(3) Prof. Greenhill has not cited a single instance to justify his charge that I am at variance with my own definition of the weight of a body in the majority of the subsequent examples.

(4) He now seems to admit that in my hydrostatical equations pressure may be expressed in pounds on the square foot, but to claim that it can be done only in a clumsy manner. There is doubtless a certain clumsiness, but it seems to me to be due to the employment of a clumsy set of units.

(5) Your reviewer still demands that I should give the dimensions of the earth, not in terms of the actual metre, but in terms of what the original designers of the metre intended it to be; but he gives no reason for this strange demand.

(6) If the knot is a unit of velocity, the term *knots per hour* is of course redundant. I have always considered it an abbreviation, but have no means at hand of settling the point.

(7) Prof. Greenhill tacitly admits that he was in error in accusing me of misusing the term *elongation*.

(8) He makes no attempt to substantiate his statement that my equations of energy were not expressed in proper form.

(9) He does not answer my question as to which of the most recent treatises on dynamics my treatment of units shows me to have read without profit and discrimination.

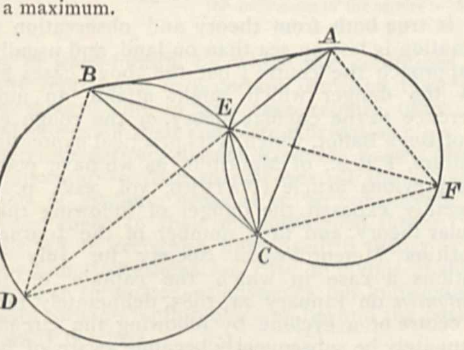
Edinburgh, May 31. J. G. MACGREGOR.

Further Use of Ptolemy's Theorem (Euclid, VI. D.) for a Problem in Maxima and Minima.

To find E within $\triangle ABC$ such that

$$AE \sin BEC + BE \sin CEA + CE \sin AEB$$

shall be a maximum.



Keep BEC constant; produce AE to cut circum-circle of BEC (which is then a fixed circle) in D.

Then $\sin BEA = \sin BED = \sin BCD$,

$\sin AEC = \sin CED = \sin CBD$,

and $\sin BEC = \sin BDC$;

$$\therefore \frac{BC}{\sin BEC} = \frac{CD}{\sin AEC} = \frac{DB}{\sin AEB};$$

$\therefore AE \sin BEC + BE \sin CEA + CE \sin AEB$

is proportional to

$$AE \cdot BC + BE \cdot CD + CE \cdot BD,$$

and therefore to

$$AE \cdot BC + ED \cdot BC. \quad \text{(Eu. VI. D)},$$

which

$$= AD \cdot BC.$$

For a maximum AE passes through centre of circum-circle of BEC.

Similarly BE passes through centre of circum-circle of CEA. Let it cut it again in F.

$\angle BCE = \angle BDE$,

$= \angle BFA$ in same segment of circle through F, A, B, D,

$= \angle ACE$.

Similarly

AE, BE bisect $\angle$ CAB, ABC.

$\therefore$ E is the in-centre of $\triangle ABC$.

Bedford. E. M. LANGLEY.

Davis's "Biology."

IF I may argue from the contents of Mr. Davis's book, he should be a good judge of what constitutes "falling into a common mistake," and yet I cannot accept his opinion as to my having accomplished this feat. I have refrained from enumerating the common mistakes which his little book contains, but I am not prepared to allow him to lay down the law as to educational methods. In my opinion it is a grievous error to present any subject of study to University students under two aspects, that of "pass" and that of "honours." Whatever is worth doing at all (in academic exercises) is worth doing well, and no regulations sanctioned by any University Senate—however philanthropic, incompetent, and imperial—can make the perennial iteration of the statements in a cram-book concerning six plants and six animals a satisfactory substitute for the study of zoological and botanical science, or anything but a pernicious torturing of the youthful mind. THE REVIEWER.

M. FAYE'S THEORY OF STORMS.[1]

ACCORDING to M. Faye, "There exist in meteorology two theories diametrically opposed—one which considers air-whirls round a vertical axis, including cyclones, typhoons, tornadoes, and waterspouts, to originate in the upper currents of the atmosphere; and the other which considers each of these as the effect of a local rarefaction, giving rise at the surface of the ground, in an atmosphere in a more or less unstable condition, to an ascending current of air, which borrows a gyratory tendency from the rotation of the ground itself." Such is the opening sentence of the pamphlet before us, which embodies a *résumé* of M. Faye's discussions in the French Academy with those who do not accept his peculiar views on the generation of atmospheric disturbances.

M. Faye upholds the former theory with that incisive vigour which characterizes our Gallic neighbours, and attacks the meteorologists with whose writings he is acquainted, beginning with poor Franklin and ending with Sprung in 1885, without mercy, but at the same time without the smallest reference to physics apart from mechanics.

Before pointing out some of the grave errors of fact, as well as theory, into which we deem M. Faye to have fallen, it may be as well to see if we cannot attempt a reconciliation between these two opposite views, which are considered to be prevalent.

To avoid mixing up tornadoes and cyclones, which we hold to be, if not generically, at all events specifically, distinct, let us first consider the former alone. The point

[1] "Sur les Tempêtes." Par M. H. Faye. (Paris: Gauthier-Villars, 1887.)

that M. Faye insists upon all through is, that these arise solely through inequalities in the upper currents, causing gyration round a vertical axis, which, like a river eddy, is propagated from above downwards, by a *descending motion of the air*. M. Colladon, referring to M. Faye's view, describes the supposed action as "un mouvement tourbillonnaire aérien constituant à son intérieur une trombe *aspiratrice* à mouvement *descendant*." M. Faye, therefore, postulates two points: (1) that the movement commences above; (2) that it is propagated downwards by a descending motion, accompanied by gyration round a vertical axis. The opposite theory, as presented by M. Faye, is the exact inverse of this, since it makes the action (1) commence at the earth's surface; (2) propagate itself upwards; and (3) borrow its gyration from that of the earth. Here, however, we find ourselves distinctly at issue with M. Faye, for we do not believe that the leaders of modern meteorology entertain any such view as the latter. The surface of the earth is the most unlikely birthplace for a tornado, whirlwind, or waterspout. In order to maintain an ascending current, the air must be nearly saturated, and this will generally occur only in and near the lowest cloud stratum. The vertical temperature gradient and disturbances which start the action, will likewise operate most effectively at this level, so that all the conditions which unite to cause a tornado will tend to commence at some distance above the earth's surface. On the question of level, therefore, we may invite M. Faye to agree with us. Then comes the question of the downward propagation.

The entire gist of the question appears to us to lie in this downward propagation. The physical theory developed by Ferrel and Sprung makes the action commence in a slight upward motion in unstable air, due to a temperature inequality or some other cause, the only other condition being a gentle gyratory motion relative to some central point, which is never wanting in a cyclonic area. Once the motion is started, and the air which feeds it is nearly or quite saturated, the action will go on and be propagated downwards, not by a descent of the *air*, but by the transference of the physical conditions which favour the continuance and maximum development of the "courant ascendant." The increasing rapidity of gyration of the air as it approaches the axis, however gentle it may be at starting, only allows it to partially feed the initial and continually reproduced vacuum, which is thus compelled to draw its supplies chiefly from the non-gyrating air at the lower end of the aërial shaft. As this is drawn upwards, the centrally aspired surrounding air is made to gyrate more rapidly (partly by the friction of the superjacent rotating layer), and thus the gyratory and other *conditions* are propagated downwards until a balance is struck between supply and demand.

The theory thus sketched may be termed the modern theory of aspiration as applied to tornadoes, and will, we venture to think, be found to meet all M. Faye's objections to the first crude notions which prevailed in past years from a study of a few isolated surface conditions.

Before proceeding to notice the objections which M. Faye brings against the existence of either an upward current or any sort of aspiration in tornadoes, we must first touch upon the cognate question of cyclone generation, which he explains on the same principles;[1] and here, without attempting to give any review of the modern theory, which involves as a primary condition a horizontal temperature anomaly over a considerable area, we may observe that the two main objections brought by M. Faye against the ordinary view of their formation are, (1) that it assumes the existence of centripetal currents, and hence aspiration towards their axes; (2) that it gives no explanation of their movements over the earth's surface.

With respect to the first objection, M. Faye draws attention to a principle which he develops on p. 46, according to which the isobars in the temperate zone do not correctly represent the motions of the air in a cyclone, and says we must look at the isobars in a tropical cyclone if we wish to arrive at correct conclusions.

Here, according to M. Faye (pp. 2 and 46), where "by the *ancient* theory the direction of the wind ought to cut the isobar at an angle of nearly 90°, the angle is sensibly nothing; the pretended centripetal component disappears; and the isobars and the wind arrows display an almost rigorous *circularity*." Again, on p. 12 he ridicules the idea of a barometric gradient in the *tropics*, "where the wind blows precisely *along* the isobars." It is with no desire to indulge in mere polemic that we take up the gauntlet thus thrown down, but the magnificent work of that most careful and renowned inductive meteorologist Prof. Loomis which he has been lately revising, enables us to show most conclusively not only that in the latitude of the Philippines which is nearly the equatorial limit of true cyclones, the direction of the wind in a particularly violent and well observed typhoon cut the isobars right through at the large angle of 62°; but that an extensive comparison of similar conditions, embraced in a large number of violent storms in different latitudes, shows that the angle between the winds and the isobars *increases as it should do according to theory from the poles to the equator*.

The accompanying figure represents the observations accurately, except that the isobars were not as there exactly circular; while the following table shows at a glance how entirely opposed M. Faye's statement is to the true facts, in the very region where he says, "les isobares elles-mêmes dessinent sur le sol comme les flèches du vent un édifice cyclonique *non encore déformé*." We have no hesitation therefore in saying that these observations of Prof. Loomis not only give the death-blow, if one were needed, to the purely circular theory of Reid and Piddington, but constitute a *conclusive* argument against M. Faye's theory of downward gyratory currents and non-aspiration in *cyclones*.

Inclination of the Wind to the Isobars in VIOLENT *Storms.*

	Latitude.	Inclination of wind to isobar.
	° ′	° ′
Arctic Regions ...	70 56 ...	28 35
Atlantic Ocean ...	56 15 ...	30 6
United States ...	45 0 ...	40 3
India and Bay of Bengal ...	20 48 ...	57 12
Philippine Islands ...	14 35 ...	62 12

It is true both from theory and observation that the inclination is less on sea than on land, and usually less as we approach the centre; but the above cases suffice to show the danger which might attend an unmodified adherence to the circular theory, or the rough empirical law of Buys Ballot, which is its practical expression. Dr. Meldrum, F.R.S., of Mauritius, as we have pointed out in a previous article (NATURE, vol. xxvi. p. 31), has frequently exposed the danger of following the purely circular theory, and in a number of the Journal of the Mauritius Meteorological Society for July 1883, he mentions a case in which the captain of the ship *Calédonien* on January 24, 1883, deliberately ran it into the centre of a cyclone by following the circular rules. Fortunately he subsequently became aware of his error, and altered his course just in time to escape the centre.

The second objection brought by M. Faye against the physical theory of cyclones is, that it cannot explain their general motions and course over the earth. We admit that the partial theory, sketched in his opening statement, which he considers to represent the modern meteoro-

[1] There is no real connecting link between the two, *i.e.* the smaller cyclones do not begin where the larger tornadoes leave off. The average size of 600 tornadoes in the United States was found to be 1085 *yards*. The average size of the cyclones is as many *miles*.

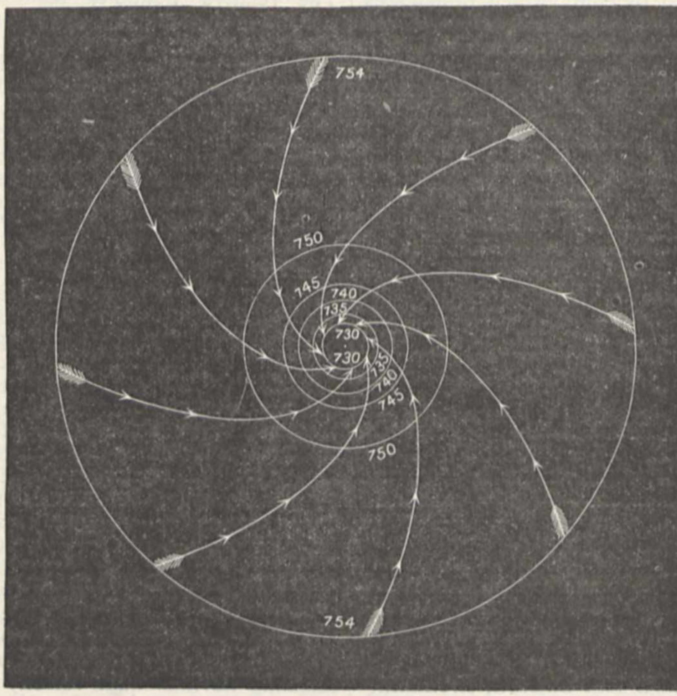
logical views, could scarcely hope to account for this; but if he will allow the meteorologists to rise with him a few thousand feet above the ground, he will find that the "*drift* theory," of which he appears to regard himself as the discoverer and sole exponent, has for some years been recognized as one of the chief possible causes of the motion of cyclonic systems.

Prof. Ferrel, a representative *deductive* meteorologist, considers the motions of the upper and middle currents to be the *principal* cause of the motion of a cyclone in longitude; its motion in latitude, which is generally towards the poles, being due to the inherent tendency which a mass of fluid gyrating in the same sense as the hemisphere in which it is situated, has to press towards its pole.

Prof. Loomis, an equally representative *inductive* meteorologist, is more cautious; but in his latest work,[1] while admitting the existence of numerous other physical factors to account for the frequently anomalous movements of storm centres—which M. Faye elegantly ignores—he agrees in attributing their *general* directions of translation to the *general* extrinsic movement of the atmosphere at the time, at some height above the surface, in combination with the intrinsic mechanical principle just mentioned.

That these are not the *sole* causes of the motion of cyclones may, however, be freely admitted, and we quite agree with the remark which M. Faye triumphantly quotes in italics from Dr. Sprung's recent "Lehrbuch," on p. 14, viz. that "none of the theories which have been put forward will alone suffice to *completely* explain the motion of translation of cyclones."

Many facts, such as the observed direction of the upper clouds over and surrounding a cyclone, the velocities at the surface in different quadrants, the retardation of the barometric minima at mountain stations, and the frequently small elevation reached by the entire disturbance (not more than 6500 feet according to Loomis)—which are all entirely overlooked by M. Faye—tally more with a species of wave-motion by which the conditions are continually reproduced in a certain direction than with the drift theory, and in any case require other and additional causes for their complete elucidation.



The Manilla cyclone of October 20, 1882. The arrows denote the direction of the wind; the circles denote the isobars at intervals of 5mm.; the inclination of the arrows to the isobars was constant all through, and = 62°·2.

We therefore entirely dissent from M. Faye's dictum that the failure up to date to discover all the causes of the motion of cyclonic areas is to be considered "an irremediable check to their meteorological theory," and we equally fail to recognize how the drift theory as put forward by him strengthens his case in favour of downward motion in tornadoes, or advances our knowledge of cyclone and tornado motion one step beyond the position it has already reached.

To return to tornadoes.

Fully armed with his preconceived theory of gyration, due to inequalities in the velocity of the upper currents, causing a downward motion of air along the axis of the whirl, and completely disregarding all evidence of upward motion or aspiration, M. Faye devotes the main part of his pamphlet to criticizing in turn the various experiments and opinions of MM. Weyher, Colladon, Lasne, and Schwedoff, with the result that he likes none of them, for the very obvious reason that, while they differ from one another in certain points, they all demand aspiration and upward motion along the axis.

We have not space to follow all these attacks in detail, but we venture to think that before attempting to strangle all adverse hypotheses it would have been wise if M. Faye had placed his own theory on a substantial basis of either physical and mechanical principles, or experiment. As it is, the sole foundations he appears to rest upon are (1) the analogy of the river eddy, and (2) the *fancied* absence of all indications of upward aspiration either during or after the passage of a tornado.

Regarding (1) we need only refer to M. Weyher's experiments, which we recently reviewed in NATURE, in

[1] "Contributions to Meteorology," chap. ii. p. 142, revised edition, 1887.

order to point out that, by causing rotation at the surface, M. Weyher found himself unable to produce a gyratory system extending downwards into the liquid from the area of rotation. On the other hand, he always found rotation, whether above or below, produce aspiration (accompanied by gyration) *towards* the area initially set in motion. According to these results, therefore, river eddies produced by inequalities in the horizontal flow cannot propagate themselves *below the area of flow disturbance.*

Now it is precisely this very form of river eddy which M. Faye takes as his analogue to the aërial tornado, and it is here that his argument fails; for, while he draws attention to the system of downward motion and gyration in an eddy caused by an outflow through an orifice in the bottom of a vessel containing liquid, where such motion and gyration is evidently caused by the outflow, he is obliged to avoid all reference to outflow at the surface as a cause in the supposed downward atmospheric gyrations. At the same time he imagines that an entirely similar system takes place, in the river, and the atmospheric eddies, as in that produced by efflux, which propagates itself downwards simply through initial rotations taking place in the upper portions, of the liquid in the one case, and of the atmosphere in the other. We have no hesitation in saying that even if such an action were possible, which we strongly doubt, it is in direct opposition to all that we know of tornadoes, either deductively from physical theory, or inductively from the facts which have been recorded up to date.

It would be a laborious, though at the same time distinctly easy, task, to point out the numerous physical facts which accord with the upward aspiration and downward propagation of *conditions* only, and which are utterly opposed to M. Faye's theory of downward motion of the *air.* It would be equally easy to quote numerous observations showing the objective reality, which M. Faye questions, of upward motion in a tornado. Prof. Loomis, for example, who is noted for his caution, relates the following pregnant incident in his own life, in his preface to the revised "Contributions":—"In February 1842 a tornado of unusual violence passed within 20 miles of Hudson. As soon as I received the news, I started out with chain and compass to make a thorough survey of the track, and succeeded to my entire satisfaction. As the tornado passed over a forest of heavy timber, I had the best opportunity to learn the direction of the wind from the prostrate trees; and, by measuring the direction of the trees as they lay piled one upon another, I determined the successive changes in the direction of the wind. *The facts demonstrated incontestably that the movement of the wind was spirally inward and upward, circulating from right to left about the centre of the tornado.* This tornado was but an incident in a great storm which swept over the United States . . ."; and he goes on to say that the results of his subsequent investigation of the latter showed that neither the purely circular theory of Redfield nor the purely inward theory of Espy was correct. The truth, as usual, lay between these two extremes, and the wind, like that shown in the diagram of the Manilla cyclone, really blew in a spiral, curving in towards the centre. Any of the accounts published by the United States Signal Service afford equally strong evidence in favour of both aspiration towards the centres and motion up the axes of the tornadoes. Thus, in the Report furnished by Rev. Charles Brooke, of the West Cambridge tornado of August 22, 1851, the following remark occurs: "No one saw any object driven *downward* by it, but all testify to its taking things *up*" (the italics are in the original); and then follows a list of articles taken *up* and carried, such as boards and slates, to a distance of 3 miles, a large barn 15 feet, a freight-car 60 feet, &c.

Again, in the Official Report of the Iowa and Illinois tornado of May 22, 1873, different witnesses say: "Saw boards whirling round in the funnel." "While the whirlwind was on the river, the water ceased to flow over the dam, although the river at the time was high." "Saw rails *flying out from the summit* [of the column]; an average rail weighs about forty pounds." And we may close the list with one quoted by Ferrel as a well-authenticated case, in the tornado at Mount Carmel, Illinois, June 4, 1877, in which "the spire, vane, and gilded ball of the Methodist church were carried 15 miles to the north-eastward." The whole evidence, in fact, both in tornadoes, and in their milder form of water and sand spouts, is overwhelmingly against M. Faye's views, and in favour of upward motion and aspiration to their very summits.

In his endeavour to bolster up a theory weak at all points, M. Faye seizes upon the well-known phenomenon of the central calm in cyclones, and cites one which occurred in the typhoon at Manilla on October 20, 1882, as proving the general existence of a downward current. In this case, while the thermometer during the first half of the storm marked 24° C., it rose during the passage of the central calm to 31° C., after which it fell again to 24° C. The relative humidity followed analogously inverse changes, falling from 98 to 53—an extraordinary degree of dryness for such a climate. With reference to this circumstance, M. Faye quotes with considerable triumph a remark of Dr. Sprung to the effect that "such a characteristic phenomenon can only be explained by admitting the existence of a descending current at the centre of this cyclone." Locally, and for a short space upwards, there might have been; but these particular features, accompanied by a clearing of the sky, and known as the "eye of the storm," are the exception and not the rule, even in tropical cyclones. It is, moreover, readily seen that if there were a descending current of any extent or velocity in cyclones it would necessitate *an outflow along the surface* for some distance round their centres—a condition utterly opposed to all observation and experience. M. Faye makes one more attempt to support the differential-current-motion hypothesis of tornado and cyclone generation, by referring to certain empirical laws of the relation of the former to the latter disturbances, deduced by Mr. Finley, of the United States Signal Service. For example, (1) the fact that tornadoes are usually found in the south-south-east or dangerous octant of a cyclone; and (2) a law formulated by M. Faye himself, according to which their trajectories, as traced by the areas of destruction, are parallel to those of the cyclones in which they are generated.

The first of these facts has been known for some time, and applies equally to thunderstorms. M. Faye considers it to arise from the air shot *down* from the upper currents reaching its maximum velocity "where the velocity of translation is added to that of rotation," an idea which concentrates in a truly tornadic manner two fundamental errors which pervade his work. Modern investigation has shown that the velocities of rotation and translation in cyclones are quite independent, and is in this matter as far ahead of M. Faye's view as his knowledge of cyclonic systems is superior to that of Franklin, who had no isobaric charts to help him.

Again, the south-east portion of a cyclone is precisely where, according to the corrected theory of aspiration, the conditions are most favourable to the production of local and parasitical disturbances of equilibrium, and since such disturbances take their birth in or just below the cloud-strata, their trajectories will naturally tend to follow the course of these higher strata, which in this part of the cyclone *generally* coincides with that of its translation. The violent motion, moreover, which M. Faye considers to be such an essential primary condition in the generation of tornadoes is by no means necessary, as Prof. James Thomson, among others, has pointed out in a recent paper before the British Association (British Association Reports, 1884, p. 641.)

Besides the objections we have all along pointed out to the existence of the downward current in cyclones, it renders M. Faye perfectly helpless when he contemplates an anticyclone. In the presence of such a formidable foe he is completely disarmed. Here, just where a downward current would come in really useful, he finds he has *used it all up*. All he can say, therefore, is that they have nothing cyclonic about them, which is quite true.

M. Faye concludes by drawing up a list of questions which relate to the phenomena exhibited by cyclones, tornadoes, and waterspouts, and which he considers yet unsolved. Some, doubtless, still await a more complete explanation, but we think the list might be considerably curtailed if M. Faye would descend, if possible, in one of his favourite eddies, and meet the *aspiring* meteorologist half-way. Atmospheric phenomena seldom present themselves in the form of purely mechanical problems. If, as M. Faye says, the question "is not one which can be treated by actual methods of rational mechanics on which everyone can agree," we are equally confident that it is one whose solution cannot be attempted without the aid of rational physics, or without reference to the facts already established by observation.

E. DOUGLAS ARCHIBALD.

THE VISITATION OF THE ROYAL OBSERVATORY.

THE Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory was read at the annual visitation on June 2.

One of the first points touched on in the Report is the threatened railway invasion of the Observatory.

The subject of approaching railways has again, after a lapse of many years, engaged our serious attention. Early in March notice was received from the Home Office of a proposal to carry a railway (in extension of the authorized Bexley Heath Railway) in a tunnel across Blackheath, the nearest point being 840 yards from the Observatory. As there was reason to believe that this railway might injuriously affect the Observatory, preliminary observations of the effect produced by trains on the existing Greenwich and Maze Hill Railway were at once commenced, the observations being made on six nights with the transit-circle, and the disturbance in the image of the wires, as seen by reflection from the trough of mercury, being noted. It resulted from these experiments that trains on this railway caused great disturbance during their passage, not only on the section between Greenwich and Maze Hill, the nearest point of which is 570 yards from the transit-circle, but also on the line beyond Greenwich on the London side and beyond Maze Hill on the Woolwich side. The distances of the Greenwich and Maze Hill stations from the Observatory are about 970 and 670 yards respectively. There was also evidence of disturbance caused presumably by trains on the Lewisham, Blackheath, and Charlton line, at a distance of about a mile from the Observatory, but we could only infer the times of passage of these trains from the published time-tables.

In order to establish conclusively the connection between definite disturbances and trains, arrangements were made to note the times of arrival and departure of trains on the Greenwich line and at Blackheath, facilities for doing this having been courteously given by Mr. Myles Fenton, the Manager of the South-Eastern Railway. Observations were made on this plan on five nights, one observer being stationed at the transit-circle to record all disturbances of the reflected image, while another observer travelling up and down the Greenwich line, and a third observer at Blackheath, noted the times of arrival at and departure from the stations. It was found that the disturbance was very great during the passage of trains between Greenwich and Maze Hill, the reflected image being invisible while the train was in the tunnel, at a minimum distance of 570 yards, and that there was considerable disturbance during the passage of trains through the Blackheath-Charlton tunnel, at a distance of a mile, the reflected image becoming occasionally invisible. As the tunnel of the proposed railway would be similar in character to this, but at half the distance, it was concluded that it would cause so great a disturbance as to make delicate observations impossible. On my notifying this to the Admiralty, the Bill was opposed on the part of the Government, and as a consequence of this the clauses authorizing the construction of the railway across Blackheath were abandoned.

I may here mention that the extension of the London, Chatham, and Dover Railway from Blackheath Hill to Greenwich, which was authorized in 1881, is now in course of construction. I hope that, though the terminus of this line is distant only 620 yards from the Observatory, the tremor from trains will not have sufficient time to produce the full accumulated effect in the short interval between Blackheath Hill station and the terminus. But if at any future time a further extension of this line should be proposed, the question would require very careful consideration in the interests of the Royal Observatory.

The following statement shows the number of observations made with the transit-circle in the period of 356 days ending May 10, 1888:—

Transits, the separate limbs being counted as separate observations	5304
Determinations of collimation error	294
Determinations of level error	351
Circle observations	5067
Determinations of nadir point (included in the number of circle observations)	331
Reflection-observations of stars (similarly included) ...	503

About 350 transits (included in the above number) have been observed with the reversion-prism, to determine personality depending on the direction of motion.

The very bad weather in the first four months of this year has seriously affected the number of observations with the transit-circle.

The total number of observations made with the altazimuth is as follows, the observations having been as usual restricted to the first and last quarters in each lunation, except during the winter, when, in the absence of suitable objects for equatorial observations, the moon was observed throughout the lunation.

Azimuths of the moon and stars	354
Azimuths of the azimuth mark	114
Azimuths of the collimating mark	116
Zenith distances of the moon and stars	209
Zenith distances of the collimating mark......	116

In consequence of the building operations for the extension of the computing-rooms the collimating mark was dismounted on November 9, and the view of the azimuth mark has been obstructed by the new building from the beginning of December. Since then the collimation and azimuth errors have been determined entirely by observations of high and low stars. It is proposed, when the work on the new building is completed, to select two azimuth marks, one distant and the other sufficiently near to be seen in the foggy weather of the winter months. For distinct vision of the latter a lens of very long focus would be required, and it would thus be available strictly as a collimating mark.

All will regret to hear that no progress has been made since the date of the last Report in the construction of the new 28-inch refractor, owing to difficulty in obtaining the crown disk. The flint disk made by Messrs. Chance seems to be satisfactory, but up to the present neither that firm nor M. Feil's successor has succeeded in making a crown disk.

Attempts have been made to show if anything is gained in sidereal photography by using curved plates. For this purpose a 4-inch photographic object-glass by Dallmeyer, belonging to one of the photoheliographs, was mounted at the end of June in a light wooden tube, and firmly attached to the side of the telescope tube and parallel to it, to carry out experiments on the extent of field available on plane and curved plates respectively, the latter being moulded by Messrs. Chance to a radius of 22 inches, corresponding to the curvature of the field, if the circle of least confusion be taken for the image. We read:—

Forty-one photographs have been taken of the Pleiades and other objects with different exposures and in different parts of the plate, 13 of these being on curved plates. In these experiments the Sheepshanks refractor was used as directing telescope, the image of a star being kept on its cross-wires during the exposure of a plate by means of the slow motions. The plates measure 6 inches × 6 inches, representing 5¾°. × 5¾°, and it is found that on the flat plates the star images are sensibly circular to a distance of nearly 2° from the centre of the field, while micrometric measures of these plates show that for some distance beyond this limit the relative places of stars can still be measured with an accuracy exceeding that of meridian observations, and with no sensible systematic error depending on magnitude or duration of exposure. Comparison of the results on flat and curved plates respectively indicates that the advantages of using the latter are doubtful. As the Dallmeyer object-glass is peculiar in having the flint outside, it was reversed in the cell in the course of the experiments, and some photographs were taken with it in this position, the flint being inside. It appeared on comparing the results that a somewhat better field is obtained with the flint outside. A photographic object-glass of 6 inches aperture and 6 feet focal length, made by Sir H. Grubb for experiment, was mounted at the end of April in place of the 4-inch object-glass, and some trial photographs of stars have been taken with it.

Special arrangements were made for observing occultations during the total eclipse of the moon on January 28, observers being stationed at nine instruments, but clouds covered the moon almost continuously during totality. Various devices were adopted with a view to facilitating the observation in rapid succession of the faint stars occulted during the eclipse. In the case of two instruments the eye-piece was mounted excentrically at the distance of the radius of the moon's image from the axis, so that without disturbing the position of the telescope any point of the limb could be brought into the centre of the field. For setting the position-circles rapidly in the dark, cardboard circles with notches at important points or with the figures indicated with luminous paint, were found very useful.

The spectroscopic observations of motions of stars in the line of sight have been continued. The recent observations of Algol confirm the previous results indicating orbital motion, but further observations are required to establish the fact. At the request of Mr. Lockyer, the spectra of α Orionis, α Herculis, γ Cassiopeiæ, and β Lyræ have been examined on several occasions.

That the daily record of the solar surface is gradually getting more complete is clearly shown by what happened in the year 1887, in which Greenwich photographs are available on 188 days; photographs from India or Mauritius filled up the gaps in the series on 173 days, thus making a total of 361 days out of 365 on which photographs have been measured in this year.

The sun has been free from spots on 106 days in the year 1887, and the areas of both spots and faculæ have diminished since the date of the last Report. With the exception of a fine group seen during three rotations in May, June, and July, and of three other groups, one in July and two in December, all of these being in the southern hemisphere, there has been a complete absence of conspicuous spots. The entire spotted area has rarely amounted to 1/2000 of the sun's visible hemisphere, and the mean is less than one-sixth of that recorded in 1883, being intermediate between those for the years 1875 and 1876.

In view of the diminution of the current work as the minimum of sunspots approaches, the further discussion of the results of former years has been commenced, and arrangements have been made through the Solar Physics Committee to complete the Greenwich results as far as practicable by the measurement of photographs taken elsewhere, particularly at Ely and Cambridge, U.S. From the beginning of 1882 the photographic record is practically complete, the measurement of Indian photographs to fill up gaps in the Greenwich series having been undertaken from December 22, 1881. The further discussion of results has, therefore, been commenced from that date, and the projected areas of spots (uncorrected for foreshortening) have been formed to May 29, 1885, and from the beginning of 1886 to the end of 1887. The ledgers in which the areas and positions of the spots of a group are collected and the mean area and position of the group, deduced for each day and for the whole period of visibility, have been formed for 1886 and 1887, and their completion for the years 1882 to 1885 will now be taken in hand. Two new forms have been prepared to exhibit the distribution of spotted area on each day for every degree of latitude and for every 10° of longitude, mean results being taken for each rotation and for each year.

With regard to magnetic observations we read that the only important change is the substitution, since October last, of a wooden bar loaded with lead, of the same size and weight as the declination-magnet, for the brass bar hitherto used for determination of the torsion of the suspending skein, a very weak trace of magnetism having been detected in the brass bar.

The earth-current observations have been attended with some difficulties. We read :—

The earth-current wires, which were damaged by the snowstorm of 1886 December 26, were not completely repaired till August 1887, when it was found that the earth-plate at Angerstein Wharf had been stolen, another earth-plate being then supplied. A renewal of the earth-current wires concurrently with the telegraph wires on this portion of the South-Eastern Railway was arranged, in concert with Mr. Leonard, but this has not been carried out owing to a rise in the price of copper. Five measures of resistance of the earth-current wires have been made since the last Report, but the results are not satisfactory, owing presumably to the bad condition of the wires. On the line from Angerstein Wharf to Ladywell, 7½ miles in length, the measures of resistance range from 220 to 285 ohms, and on the Blackheath to North Kent East Junction line, 5 miles long, the measures range from 230 to 262 ohms. Under these circumstances it seems hopeless to attempt to express the measures of ordinates on the earth-current sheets in terms of the electrical units until the conditions of the circuits have been improved. A further difficulty arises in discussing the small diurnal inequality on the earth-current registers in consequence of the circumstance (to which attention was first drawn by Mr. A. J. S. Adams, of the Post Office Telegraphs) that there is a slight dislocation in the Angerstein Wharf to Ladywell trace shortly after sunset with sudden return to the original position shortly before sunrise, representing an increased current from Ladywell to Angerstein Wharf, or a diminished potential at Angerstein Wharf during the night hours. Possibly this may be connected with the electric lighting in the vicinity of the earth plate. It appears to have commenced in 1883, becoming more pronounced in 1884.

The following are the principal results for the magnetic elements for 1887 :—

Approximate mean declination . .	17° 47' W.
Mean horizontal force . .	3·9419 (in British units) 1·8175 (in Metric units)
Mean dip	67° 25' 45" (by 9-inch needles) 67 26 20 (by 6-inch needles) 67 27 13 (by 3-inch needles)

In the year 1887 there were only three days of great magnetic disturbance, but there were also about twenty other days of lesser disturbance for which tracings of the photographic curves will be published, as well as tracings of the registers on four typical quiet days.

The mean daily motion of the air in 1887 was 275 miles, being 9 miles below the average of the preceding twenty years. The greatest daily motion was 829 miles on March 23; and the least, 59 miles on November 16. The only recorded pressure exceeding 20 pounds on the square foot was 20·5 pounds on April 6.

During the year 1887, Osler's anemometer showed an excess of about 17 revolutions of the vane in the positive direction N., E., S., W., N., excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded during 1887 by Campbell's sunshine instrument (Prof. Stokes's improved pattern) was 1401, which is about 190 hours above the average of the preceding ten years. The aggregate number of hours during which the sun was above the horizon was 4454, so that the mean proportion of sunshine for the year was 0·315, constant sunshine being represented by 1.

The rainfall in 1887 was 19·9 inches, being 4·8 inches below the average of the preceding forty-six years.

There has been no failure in the automatic drop of the Greenwich time-ball, but on four days the ball was not raised on account of the violence of the wind.

The automatic drop of the Deal time-ball failed on six days owing to interruption of the telegraphic connections, and on two days high wind prevented the raising of the ball. There has been no case of failure of the 1 p.m. signal to the Post Office Telegraphs.

There have been twenty-three failures in the automatic signals from the Westminster clock since the date of the last report. The error of the clock was insensible on 25 per cent. of the days of observation, 1s. on 38 per cent., 2s. on 20 per cent., 3s. on 15 per cent., and 4s. on 2 per cent.

Provision has been made in the estimates for the expense of a re-determination of the difference of longitude between Greenwich and Paris, and correspondence has been carried on with the French authorities on the subject. The regretted death of General Perrier occurred before any definite plan had been settled; but his successor, M. le Commandant Bassot, has taken the matter up warmly in concert with Admiral Mouchez, and the French Bureau des Longitudes has approved the scheme, which is to include a determination of the longitude of Dunkirk. Three French delegates (M. Lœwy, M. Bassot, and M. Defforges) propose to visit Greenwich very shortly to settle the details of the plan of operations which it is intended to carry out in the autumn. In preparation for the work, Mr. Turner and Mr. Lewis have observed for practice, by eye and ear, a number of galvanometer signals sent by another observer and automatically registered on a chronograph, five sets of ten signals having been recorded on each of seven days.

The Report concludes as follows:—

In my last Report it was suggested that the instrumental equipment of the Observatory should be supplemented by a photographic refractor of 13 inches aperture (equatorially mounted) to enable Greenwich, as the National Observatory, to take its share in the scheme for forming a photographic map of the heavens, and for thus extending our knowledge of the places of the fixed stars. Consequent on the resolution of the Board of Visitors at the last visitation, I brought this question of the insufficiency of our instruments for the present wants of astronomy to the notice of the Admiralty and of the Chancellor of the Exchequer, and the matter is still under the consideration of the Government. If the Royal Observatory is to take part in this work of carrying out one of the principal objects for which the Astronomer-Royal was appointed, it appears to be essential that a decision should be arrived at without delay, in view of the circumstance that thirteen Observatories (including those of Melbourne and Sydney in our own colonies) have already ordered their instruments, which are to be completed by the end of the present year.

Allusion was made in the last Report to the increased demands made on the Observatory in recent years both by the scientific and the general public, and in view of the consequent development of work it now becomes necessary to review the position of the establishment, which was constituted many years ago, when the conditions were very different. In order to understand the difficulty of the present situation it is necessary to bear in mind the following facts:—In 1835 there were five assistants (excluding the chief assistant), having no computers to superintend, no extraneous work beyond the care of a relatively small number of chronometers for the Navy, no magnetic and meteorological observations, no altazimuth observations, no spectroscopic and photographic observations. At the present time there are eight assistants (excluding the chief assistant) having fifteen computers to superintend, and of this staff two assistants are absorbed by the magnetic and meteorological branch, one by the altazimuth, and two by the spectroscopic and photographic branch, leaving only three assistants to do the astronomical work, which in 1835 required five assistants, and in addition to perform all the extraneous duties which the Astronomer-Royal has felt it desirable to undertake in the public interest.

Under these circumstances it becomes a matter for serious consideration whether, unless adequate provision be made for the primary objects of the Observatory, extraneous work, such as the supply of time-signals, may not have to be dropped. The service of hourly time-signals throws considerable work on myself and the staff of the Observatory, and, as it is purely voluntary, it appears to me that a condition of its maintenance must be that arrangements shall be made to enable the proper work of the Observatory to be carried on and suitably developed.

INDUSTRIAL TRAINING.

AT a meeting held at the Mansion House on Friday last, in support of the scheme for establishing Polytechnic Institutes in South London, an able and interesting speech was delivered by Lord Salisbury. Having pointed out that of late years much had been done for primary education, he went on to show that a sound system of secondary education for the great mass of the people was not less necessary. Secondary education, as we know it at present, had been established for the benefit of classes who in the main had not to work for their living. Plainly, therefore, it was not adapted to the needs of the working classes. "What we have now to do," he continued, "is to provide an education which will develop for each man the faculties that Nature has given him in such a manner that he may be as active, profitable, and prosperous a member of the community as possible." Lord Salisbury then passed in review the efforts which have been made in London to meet the demand for technical instruction, and concluded as follows:—

"I have only one more word to say, just to call your attention to another aspect of this case and to commend it to your efforts. We live in a time when men multiply fast, but apparently the means of supporting them do not multiply as rapidly; when there is vehement competition and occasionally intervals of deep depression. And if you should look more closely, you will find that one cause at least of this phenomenon is that man, as the mere owner of muscle, is being edged out by another and more powerful competitor. Merely as an agent of physical force, as the possessor of the power of labour, the steam-engine is a competitor which drives him easily out of the market. And more and more the mere unskilled labour is being made unnecessary by the development of the forces which mechanical science has discovered. And as the world goes on, you must expect this tendency to increase. You must expect mechanical force to become more varied and more powerful and more cheap, and the competition with human arms and limbs to become more hopeless. But there is one region where the machine can never follow the human being, and that is in the exercise of thought. In skill, in cultivated mind, in the power to adapt the processes of thought to the laws of Nature, in all that we call 'skilled labour' of the highest kind, in that man must always have a monopoly, and need fear no encroachment from the competition of the steam-engine. It is to the development of his powers in that respect that the increase in the means of subsistence and the opening of new paths of self-support must be found. On all of us, in whatever position we are, is pressing, as one of the most anxious subjects of public care, the discovery of methods by which the teeming millions of this country shall be able to maintain themselves in a prosperous, decent, and comfortable condition. We cannot find in their unskilled labour a satisfaction of that want. The difficulties are enhanced by the fact that our neighbours in other countries have been sensible of the superiority which skilled education can confer, and have not been slow to take advantage of it. If we will not be left behind in the race, if we desire to find any satisfactory solution for the deepest and the most inscrutable problem of our time, if we wish our complex community and high civilization to be maintained secure from all the dangers which the presence of unfed, unprosperous, untaught millions must bring upon them, we shall do our utmost to give a healthy and a rapid development to the secondary education of the working classes."

The *Times*, commenting on the meeting addressed by Lord Salisbury, says:—

"The Prime Minister spoke of the occasion as marking an era in the development of secondary education. The expression is scarcely too emphatic. Many of those present at the Mansion House have been for years labouring for that cause, and often with little confidence that they would ever see the produce of the seed which they sowed. Now, however, the husbandman's hopes rise, for he discerns everywhere lusty shoots flourishing, and he knows that a harvest is at hand. It is no small matter to find Government recognition of the importance of manual or technical education in a Bill which will enable any School Board to promote it. What London has done other cities will do, and here much has been done, and still more is imminent. The Polytechnic and the Beaumont Institutes are admirable pioneers. The projected Institutes for South London will soon, we should hope, be established; and the Charity Commissioners have promised to grant £50,000 in aid of an Institute for the south-west parishes north of the river on condition that the same amount is contributed by the district. What limits are there to the possible benefits from a network of such institutions over London and other great cities? Even if they fail to sharpen the wits of our workers, and to prepare them for their part in that struggle which the Prime Minister eloquently described as the course of civilization, if the foreign clerk continues to oust our own youth, we may count with certainty on deep and far-extending good from institutions mingling instruction with recreation, uniting many of the good points of clubs and schools, serving to some as ladders for ambition to climb with, to others as refuges from the public-house, and introducing intellectual light into the dark places of our cities. For many a man and woman, especially at the outset of life, narrow means would lose all terror if there were open of an evening an Institute such as was described yesterday; and it would be the best palliative of that dull monotony which in some walks of life is more injurious, as it is immensely more common, than downright viciousness."

For many a day, as our readers know, we have been urging the necessity for the establishment of a proper system of technical instruction. The subject is one of such pressing importance that we have returned to it again and again, seeking to present it in many different aspects; and Lord Salisbury's speech and the article in the *Times* may be taken as indications that large classes of the community have at last begun to understand that the nation has no time to lose in setting about a task which ought long ago to have been most seriously undertaken. Even if the question had little direct relation with economic interests, it would be for many reasons desirable to secure for manual training a place among our educational methods. Attention has hitherto been too exclusively devoted in schools to such knowledge as may be derived from books. It is necessary, from the strictly educational point of view, that teachers should aim at a wider, more direct, and more practical development of the mental powers of their scholars. But other and even more fundamental interests are also concerned. The leading nations of the wórld, our rivals in industry and trade, have already perceived the benefits to be secured from a thorough mastery, on the part both of employers and employed, of the principles of science as applied to agricultural and manufacturing processes. The result is that in many of the best markets, where our supremacy as a trading people was formerly unquestioned, we find ourselves at a disadvantage; and it is certain that unless we place ourselves on a level with our competitors we shall have to pass through some very bitter national experiences. The question is really one of life and death for England. It is a question whether in the near future there are or are not to be sufficient employment and remuneration for the vast and growing masses of her population.

WEISMANN ON HEREDITY.[1]

THE fundamental property of all living matter is assimilation and consequent growth; and reproduction is merely discontinuous growth. This is most apparent in the Protozoa, where the primitive form of reproduction—division into two parts—is common. Each part exactly resembles the other part, and both the parent. Heredity in them merely means identity of bodily substance, and consequent identity of vital phenomena. In Metazoa there is a sharp distinction between reproductive cells and body cells. In many cases it is certain that the reproductive cells of each new organism arise directly from the reproductive cells of the parent. Here there is as manifestly a continuity or identity of the germ-plasma as in the Protozoa. As has already been explained by Prof. Moseley in this paper, Weismann extends this phylogenetic continuity of germ-cell, or at least of germ-plasma—the essential constituent of the germ-cell—to all the Metazoa.

In the Metazoa, the germ-cells, instead of remaining single, give rise to the vast number of somatic cells which compose the adult structure. The form, arrangement, and succession of these depend on the germ-plasma; and as there is continuity of this from generation to generation it follows that the structures derived from it are identical in each generation. Obviously this view excludes the possibility of the inheritance of acquired characters. But this inheritance has been proved neither by observation nor by experiment, and it has been impossible to conceive any satisfactory mechanism by which it could be accomplished.

Weismann believes that the theory of the inheritance of acquired characters is not required to explain the phenomena of the organic world. In the production of an acquired character two forces are at play, and these forces in relation to the organism may well be called *centripetal* and *centrifugal*. The centrifugal forces are ultimately referable to the molecular constitution of the germ-plasma, and are transmitted with the other properties of the germ-plasma from generation to generation. Changes in the centrifugal forces due to that mixing of plasmata which is the object of amphigonic reproduction constantly occur. Adaptation and differentiation result from the action of the environment (centripetal forces) on these continual changes in the possibilities of the organism. Not acquired characters, but the internal possibilities of them, are transmitted: not the results, but the centrifugal causes of them, are transmitted and accumulated by natural selection. An example will make this clear. Giraffes are certainly descended from short-necked forms. According to the old theory, during life their ancestors, by constantly stretching to reach higher and higher branches of the acacias, &c., on which they fed, elongated their necks a

[1] "Ueber die Vererbung," von Dr. August Weismann. (Jena, 1884.)

little. Each addition to the neck so acquired was transmitted to the descendant, and by accumulation of the changes thus produced the modern long-necked condition was attained. According to Weismann, what happens is this. In each generation slight variations in the length of the neck, as in the other parts of the body, occur. These variations are due to constitutional causes which are transmitted. When greater length of neck became important to the animal, those animals with necks a little longer or capable of being stretched out a little further, would have the advantage, would survive longer, and leave more offspring. The offspring, inheriting the constitution of their parents, would inherit this tendency to have longer necks. By the continual elimination in many generations of the short-necked forms, and by the seizing hold of each naturally-occurring variation, the long-necked condition would finally appear.

As variations are constantly occurring, natural selection must constantly be at work to maintain the standard of any organ. Whenever an organ ceases to be of use, or even when it becomes merely of subordinate utility, this selective maintenance falls into abeyance. A state that Weismann calls *Panmixia* results. Variations below the standard cease to be eliminated, and the organ slowly degenerates. In this way is explained degeneration through disuse: degeneration from conditions that are not harmful but merely unnecessary. In many cases organs that are not used degenerate very much during individual lives, but this occurs through failure of nutrition. Weismann believes such effects not to be transmitted. Were these effects inherited, useless organs must inevitably disappear very much more rapidly and completely than there is evidence for.

Instincts are elaborated, not by the accumulation of transmitted individual experience, but by continual selection of mental variations in the required direction. For instance, the instinct to avoid enemies arose not by accumulation of experience, for experience of the inconvenience of being devoured could hardly be transmitted, but by the naturally more timid forms surviving, and leaving more offspring than their less wary brethren.

Talent and even genius often run through several generations; and certainly mental powers can be much increased in individual lives. But the exhibition of talent and genius depends on a combination of many physical and mental conditions in which constitutional variation is ever present, and these variations are undoubtedly inheritable. Moreover, the history of families of conspicuous ability (as, for instance, that of the musical family Bach) shows that the highest development often occurs in the middle of the series, while the theory of the transmission of acquired characters would demand to find it at the end.

Selection of variations best explains cases of adaptation to new climates. But the immense influence of climate conditions on nutrition in each ontogeny must be taken into account.

Qualitative changes at first present some difficulty, but it must be remembered that qualitative changes are nearly always at bottom quantitative. A surface appears naked, though covered with many small hairs; or light-coloured, though scattered pigment-cells are present. Quantitative variations in such conditions certainly occur, and are certainly transmitted, and natural selection can readily change the number or size of hairs or pigment-cells, and produce so-called qualitative results.

It is not claimed as yet that the inheritance of acquired characters can be excluded in every case. But increasing knowledge of the conditions of life and of the functions of organs causes ever a larger and larger part of the phenomena of the organic world to be explained by the selection of naturally-arising variations.

P. CHALMERS MITCHELL.

IMPERIAL GEOLOGICAL UNION.

REFERRING to my letter on the above subject, published in NATURE, vol. xxxvi. p. 146, I beg to communicate, for the information of those interested in the matter, the substance of a report made to the Royal Society of Canada at its meeting on May 22, in Ottawa.

The Committee reported that it had, as directed, printed the letter of Sir William Dawson to the President of the Royal Society, and the first report of the Committee, and had circulated these extensively, sending them especially to geologists and Societies in Great Britain and the colonies and dependencies of the Empire. A large number of replies had been received, testifying to a somewhat general wish for union and co-operation.

The matter was then laid before the Council of the Royal Society, with the view of holding a Conference in London under its auspices. The subject was taken up by the Council in October last, and a resolution was passed and communicated to the Committee to the effect that, having regard to the existing condition of the question of scientific federation, and the various contingencies that may occur during the next few years, they do not see their way to summon such a Conference as that recommended.

In view of this resolution it was felt to be useless for the present to attempt any farther action. Still, as the desire for and appreciation of the benefits of the union contemplated seemed to be very general, and as opportunities may occur later for giving it a practical form, it was thought best by the Royal Society of Canada to continue its Committee, with power to correspond with other bodies and with persons interested. The undersigned will therefore be glad to receive any communications on the subject.

Some misconception appears to exist as to the relations of the intended movement to the International Geological Congress which is to meet in London in September next. They have in reality no connection, except that, under certain contingencies, they might be mutually helpful.

A Union of British Geologists might exercise an influence for good in connection with the plans for unification of classification, nomenclature, and mapping, which have occupied the attention of the Congress; but its function would rather be the positive one of uniting workers throughout the wide area occupied by the British Empire, and enabling them more effectually to co-operate in the extension of actual knowledge, in giving mutual aid, in enlarging the mental vision of local and special workers, in making accessible to isolated labourers the common stock of knowledge, and in preventing the interference and discordance which result from disunited effort.

That there are difficulties in the way of the realization of such a plan as applied to British and colonial geologists in the first instance, and ultimately to all English-speaking geologists, there can be no doubt; but they are continually diminishing, in consequence of greater facilities for intercourse and the rapid growth of scientific work in the various outlying parts of the Empire. The idea is thus a fruitful one, certain to be realized in the future; and possible even at present if a central nucleus could be secured for an Imperial organization. It is not impossible that the large gathering of English-speaking geologists in London in September may afford opportunity for further discussion of the plan; and if the invitation which it is understood will be given by our friends of the United States to hold the next meeting in America be accepted, this may constitute another step in the same direction.

Montreal, May 31.

J. WM. DAWSON.

NOTES.

THE Laboratory of the Marine Biological Association at Plymouth is now approaching completion, and, after the opening ceremony on the 30th inst., it will be, in all essential respects, ready for work. The salt-water reservoirs have, after several delays, been filled, and the water is now circulating freely in the tanks of the aquarium. The fittings of the main laboratory are complete on the north side, and will give accommodation for seven naturalists, besides the Resident Director. In addition to this there are the physiological and chemical laboratories, all the fittings of which are now in place, and the library is in process of formation. The Association stands very much in need of presents of books, and it is hoped that those who are interested in its work, and have duplicate copies of biological works on their shelves, will be disposed to present them to so deserving an institution. At the opening ceremony on the 30th, upwards of a hundred members and their friends are expected to be present. The fact that Parliament is in session will keep away many of those who take a liberal interest in the Association, but it is hoped that Sir Lyon Playfair, Sir Edward Clarke, and Sir Edward Birkbeck will be present to represent the Parliamentary interest. Prof. W. H. Flower will be the presiding zoologist, and with him will be many well-known men of science, including Profs. Ray Lankester, Milnes Marshall, McIntosh, C. Stewart, Dr. Günther, Mr. Adam Sedgwick, and many others. The Hydrographer has stated his intention to be present, and the naval and military element will be fully represented by the commanding officers of both services at Plymouth. The Fishmongers' Company, which has been so munificent a patron of the Association, will be fully represented by its Prime Warden, Sir James Clarke Lawrence, and several members of the Court. They have kindly undertaken the hospitable duties of the occasion, and there can be no doubt that the *déjeûner* at the Grand Hotel, and the speeches that may be expected to be made there, will form a most important part of the day's proceedings.

THE annual meeting for the election of Fellows of the Royal Society was held at the Society's rooms in Burlington House on June 7, when the following gentlemen were elected: Thomas Andrews, F.R.S.E., James Thomson Bottomley, M.A., Charles Vernon Boys, Arthur Herbert Church, M.A., Prof. Alfred George Greenhill, M.A., Lieut.-General Sir William F. D. Jervois, R.E., Prof. Charles Lapworth, LL.D., Prof. T. Jeffery Parker, Prof. John Henry Poynting, M.A., Prof. William Ramsay, Ph.D., Thomas Pridgin Teale, F.R.C.S., William Topley, F.G.S., Henry Trimen, M.B., Prof. Henry Marshall Ward, M.A., William Henry White, M.I.C.E.

DR. S. H. VINES, F.R.S., Fellow of Caius College, Cambridge, has been elected to the Sherardian Professorship of Botany at Oxford.

THE King of Sweden, who was elected an Honorary Member of the Linnean Society at the centenary anniversary meeting of that Society held at Burlington House on May 24 last, gave an audience on Friday afternoon to the President (Mr. W. Carruthers, F.R.S.), Secretaries (Messrs. B. D. Jackson and W. P. Sladen), and Librarian (Mr. Harting), and inscribed his name in the album wherein the names of all Fellows and Honorary Members have been inscribed since 1788. The Royal signatures include those of George IV., William IV., Queen Victoria, Prince Albert, the Prince of Wales, the King of the Belgians, the King of Saxony, and now the King of Sweden.

THIS week the University of Bologna is celebrating the eighth century of its existence. A congratulatory Greek ode has been written by Prof. R. C. Jebb, who represents the University of Cambridge as its senior delegate at Bologna. The verses, which are composed in the metres of Pindar's eighth Olympian ode, are suggested by the circumstance that the University of Glasgow, in which Prof. Jebb holds the Chair of Greek Literature, is the only University in this country of which the model was taken directly and exclusively from Bologna.

THE second annual *soirée* of the Middlesex Natural History and Science Society was held at the Society's rooms, 11 Chandos Street, Cavendish Square, on Thursday evening last. Lord Strafford, the Lord-Lieutenant of the county, President of the Society, was in the chair. Many objects of scientific interest were exhibited.

THE Hon. J. Collier has undertaken to paint the portrait of Prof. Williamson, which is to be presented to University College.

THE Conferences convened by the London Chamber of Commerce to consider the question of commercial education led to the appointment of a Committee for the full discussion of the subject. This Committee nominated a sub-Committee, among the members of which were Sir John Lubbock, Sir Henry Roscoe, and Sir B. Samuelson. A scheme for the improvement of commercial education has now been drawn up by the sub-Committee and sent to various business men, schoolmasters, and other authorities on education, with a request for practical suggestions. The scheme, as it stands, proposes as obligatory subjects for examination for a commercial certificate: (1) English; (2) Latin; (3*a*) French; (3*b*) German, Spanish, or Italian; (4) history of British Isles and colonies, general and modern history, including commercial history; (5) geography, physical, political, commercial, and industrial; (6) mathematics; (7) drawing. Proficiency is also required in at least one of the following: physics, chemistry, natural history, commerce, and political economy.

PROF. LÜTKEN, Director of the Zoological Museum of Copenhagen, has addressed a strong appeal to country people in Denmark to protect the sand grouse. He points out that the only countries in which the birds nested in 1863 were Denmark and Holland, but that owing to people gathering and eating the eggs no birds were hatched. He trusts that this wanton conduct may not now be repeated. The Professor feels sure that the bird can be acclimatized in Denmark, as the sandy cliffs and shores of that country are particularly suited to its breeding. The Zoological Gardens in Copenhagen have obtained a live specimen of the bird, caught in the Island of Fünen. Flocks upwards of a hundred in number have of late been seen in many parts of Denmark.

ONE of the largest pine-trees ever grown in Sweden was felled the other day in Lapland. It measured over 120 feet in height, and was 12·5 feet in diameter 2 feet from the ground.

ON the evening of May 14, about 10 p.m., a brilliant meteor was seen at Kalmar, in Sweden. It was about the size of an ordinary plate, the colour being pale yellow, and it had a train about 100 feet in length. It went in a north-westerly direction, apparently only some little height above the ground, and exploded some distance from the town with a noise like that of burning gunpowder. During its progress a whizzing sound was distinctly heard.

IN vol. iv. Part 4, of the *Indian Meteorological Memoirs*, Mr. J. Elliot gives a list and brief account of the south-west monsoon storms generated in the Bay of Bengal during the years 1882–86. This list, which contains Nos. 47–101 of the series of storms, is a continuation of that given in the sixth paper of the second volume of the *Memoirs*, and is accompanied by yearly and monthly track charts. Some of the principal storms have been fully discussed in previous parts of the *Memoirs* and in the Journal of the Bengal Asiatic Society. The retreat of the south-west monsoon in October 1866 was followed by the occurrence of three cyclones at intervals of about a fortnight. They presented such marked peculiarities that they have been specially investigated. All were generated in the immediate neighbourhood of the Andamans. The first, which began to form on November 2, is an example of a class of storms, of occasional occurrence, which pass across Southern India into the Arabian Sea, and it lasted for a fortnight. It is the first example of its kind which has been fully worked out. The second, which was also a very violent storm, was formed on November 13, and affords a marked illustration of the effect of a mass of land in modifying the motion of a cyclonic disturbance. The third storm formed on December 7, and was in many respects exactly similar to the first, excepting that it was comparatively feeble at sea and short-lived on land.

AT the meeting of the French Meteorological Society on May 1, M. Poincaré presented calculations and synoptic charts showing mean barometric heights at latitude 30° and 10° N., for every day from December 9, 1882, to December 15, 1883, and on the parallels of 40°, 50°, and 20°, for a number of selected days, and pointed out certain relations which he considered existed between the barometric movements at these latitudes, and the positions of the sun and moon, and the effect of these on the displacements of the region of the trade winds. M. Renou made a communication upon the unsatisfactory condition of actinometry, and showed that the values obtained varied according to the instruments used, the force of the wind, &c., and he submitted some of the observations made during seven years at the Observatory of the Parc Saint-Maur. The Secretary presented, on the part of M. Pictre, of Pau, a plan for the graphical representation of local observations, in connection with general weather charts, with the view of facilitating local predictions. M. d'Abbadie urged the desirability of developing the study of earthquakes, and offered to give particulars as to an inexpensive form of seismograph, and as to the observations required, to persons willing to undertake such investigations.

THE Committee of the Association for the Oral Instruction of the Deaf and Dumb have issued their Report for 1887. They express much regret that in a great many instances the children are too early removed from the school established by the Association. Parents and guardians appear to think that as soon as a fair amount of speech and lip-reading has been acquired there is no longer any need for special training. Notwithstanding this drawback, the Committee feel assured that in each year the friends of oral instruction increase in numbers, and that the time is not far distant when the manual alphabet and sign language, if retained at all, will exist only as a special requirement for cases of imperfect vision and semi-imbecility. At the Training College two grades of certificates are now granted—first-class for head, second-class for assistant teachers. During the year 1887 eleven female teachers attended the Training College, of whom six obtained first-class, and two second-class certificates.

A NEW edition of Sir Walter Buller's "History of the Birds of New Zealand" has been issued. Without going over identically the same ground, the author gives in this edition a more thoroughly complete account of the birds of a country which is second in interest to none in the world as regards its natural history. A melancholy interest attaches to the avifauna of New Zealand, where so many of the indigenous birds, remains of a most ancient fauna, are either extinct or on the verge of extinction. Sir Walter Buller deserves well of every naturalist for the wonderful pains and energy he has shown in getting together the facts for the life-histories of many of these birds, which in a few years no one will be able to procure, and he has accomplished his task ably. The scientific portion of the work and the full descriptions of the species are as well written as the accounts of the habits. The plates have been done by Keulemans, and produced by chromolithography, but, like all illustrations of birds produced by this process, they are not quite satisfactory. Insects appear to us to be capable of illustration by chromolithography, but birds do not lend themselves so readily to this method. The delay in production is excessive, and the cost very considerable, while the efforts to produce a striking plate result in some loss of exactness in the colouring of the bird, this being not strictly accurate in many cases. That this should result when the best lithographic draughtsman of birds in the world has been employed, and unlimited money been spent on the production of the plates, clearly shows us that chromolithography is, and ever will be, inferior to hand-colouring.

THE fifth monthly part of the "Cyclopædia of Education" (Swan Sonnenschein) has now been issued. The complete work will include about twelve parts.

A SECOND edition of Mr. S. R. Bottone's "Electrical Instrument-making for Amateurs" (Whittaker and Co.) has just been issued. In compliance with the request of several correspondents, the author has added a short article on the telephone.

SIR DAVID SALOMON's useful "Management of Accumulators and Private Electric Light Installations" (Whittaker and Co.) has already reached a fourth edition. The author has thoroughly revised the work and made some additions, including the "Rules and Regulations for the Prevention of Fire Risks," as laid down by the Committee of the Society of Telegraph-Engineers and Electricians.

MESSRS. GUY AND CO., at Cork, and Messrs. Simpkin, Marshall, and Co., London, have published a "Guide" to what the enthusiastic author calls "the most picturesque tour in Western Europe." By this he means a tour in the south-west of Ireland. The little volume is illustrated.

MR. LELAND'S work on "Practical Education" has reached a second edition. He will now follow up the ideas set down in this book by a series of illustrated hand-books on the minor arts and industries. The series will begin with a manual on "Drawing and Designing."

"A FRESH-WATER YARN," an illustrated account of a boat-voyage up the River Avon, is announced for immediate publication by Mr. Elliot Stock.

MR. T. FISHER UNWIN is about to publish a second edition of Mr. Edward Newman's "Birdsnesting and Bird-skinning." The work has been revised, and practically re-written, with, in addition, directions for the collection and preservation of birds, and a new chapter on bird-skinning, by Miller Christy.

MESSRS. E. AND F. N. SPON have in preparation "The Drainage of Fens and Low Lands by Gravitation and Steam Power," by W. H. Wheeler; "Practical Notes on Pipe Founding," by James W. Macfarlane; and "A System for the Construction of Crystal Models on the Type of an Ordinary Plait," by John Gorham.

THE administrators of the schools of the Caucasus have just brought out the first volume of the works of the late General Uslar. No explorer of the Caucasus has done so much as Uslar did for the ethnography of the region, yet his works are little known. In 1862 he published his remarkable researches into the Abkhazian language, and laid the foundations for a rational, most appropriate, and easy transcription of this and other Caucasian languages. Later on, he brought out similar works on the languages of the Tcherkesses, Avarians, Lakhes, and so on. He did not merely compile more or less perfect vocabularies of each language, but thoroughly learned each in turn, with the help of natives, and he considered his work worthy of publication only when he could bring out an elaborate grammar. Unhappily all his works were merely lithographed in a limited number of copies. Now the first volume has appeared at Tiflis under the title of "Ethnography of the Caucasus." It contains Uslar's work on the Abkhazian language, and several smaller articles on the principles of transcription of the Caucasian languages; on the languages of the Tcherkesses and Ubykhes; and on the grammar of the Svanetian language.

THE sporadic geographical distribution of the *Aldrovandia vesiculosa*—an aquatic plant of the family of Droseraceæ—long ago attracted the attention of botanists. Grisebach and De Candolle discussed it, and Caspary made it the subject of two well-known monographs, trying to explain the strange distribution of the *Aldrovandia*, a few individuals of which had been discovered, after much hunting for them, in localities so far apart as Arles, Bordeaux, and a very few other places in France; at isolated spots in Italy, Tyrol, and Hungary; in Silesia; about Pinsk in Lithuania; and at Calcutta. Since Caspary wrote, it has been discovered also in Brandenburg, South Bavaria, and at two other spots in Prussia. Schweinfurth discovered it in Central Africa, and Ferd. Müller in Australia; and Russian explorers have found it on the Lower Amu-daria, and in the delta of the Volga. Taking up again the whole question as to the causes of its sporadic extension, in the *Trudy* of the Kazan Society of Naturalists (vol. xvii. fasc. 1), M. Korzchinsky shows that in the delta of the Volga it grows especially in thickets of rushes. There, in the most inaccessible parts of the thickets, the water is covered with flowers of the *Aldrovandia*, while in open places it is very scarce, and the few individuals discovered rarely flower. MM. Herbich and Berdan noticed the same circumstance on the Tiniecki Lake about Cracow; and M. Korzchinsky concludes that the *Aldrovandia vesiculosa* is a feeble plant which cannot compete with other aquatic plants, and is thus compelled to seek for refuge in the shaded spots amidst the rushes where no other aquatic plants grow. The spots where the *Aldrovandia* grows now must be regarded as a few remnants of a wide region over which it formerly extended, and M. Korzchinsky compares it in this respect with the *Trapa natans*, which is also disappearing.

How far north did the Caspian Sea extend during the post-Pliocene period? This question has often been considered by geologists and geographers. Marine deposits, undoubtedly Caspian—that is, containing a fauna which is now characteristic of the Caspian Sea—have been recently found as far north as the Samara bending of the Volga; so there can be no doubt that during the post-Pliocene period a gulf of the great Aral-Caspian basin penetrated north, up the present valley of the Volga, as far as the 54th degree of north latitude. A few years ago Prof. Golovkinsky raised the question whether the post-Pliocene sediments which fill up the great depression on the middle Volga at its junction with the Kama, were not also deposited in a great lake which stood in connection with the Caspian; and this question is now answered by M. Netchayeff, who has investigated these deposits. He communicates to the Kazan Society of Naturalists (*Trudy*, vol. xvii. fasc. 5), that the brown-yellow sandy clays on the Kama about Tchistopol (55° 20′ N. lat.), contain the following fossils: *Dreyssena polymorpha*, most characteristic of the Aral-Caspian deposits all over the Trans-Caspian region, *Pisidium fontinale*, *Paludina achatina*, *P. impura*, *Limnæus fuscus*, *Helix pulchella*, and the *Hydrobia caspia* (Eichwald). The latter, according to Grimm, is one of the forms now in the Caspian Sea which are found only in that sea. We must therefore conclude that the Kazan depression of the Volga, now about 150 feet above the sea-level, *i.e.* 235 feet above the level of the Caspian, was a part of that sea at a period so close to our own as the post-Pliocene.

THE cod and whale fisheries in the north of Norway have entirely failed this spring, and it is suggested that the non-appearance of the former is due to the low temperature of the sea this season. Thus the Russian naval officers stationed on the Murman coast found in May only a surface temperature of from 1° to 2° C., and along the Norwegian coast it has been lower still. As to the whale-fishing, only 40 animals had been captured by the end of April against 200 last year. It is maintained that the present wholesale slaughter carried out by Norwegian and Russian steamers equipped with harpoon guns will eventually extirpate these animals, and some measure for their preservation is contemplated. Advices from the Arctic regions state that there was an enormous mass of drift-ice in those waters during this spring. Two sealers, the *Hekla* and the famous *Vega*, were imprisoned for more than a month in the ice to the north-east of Norway.

IN the very useful scientific methods whereby movements record themselves in curves, photography and a point moving on a smoked surface are perhaps those forms which yield the most delicate curves. In the French Société d'Encouragement, M. Mascart has called attention to a useful modification by M. Fénon, in which a bent tube of tempered steel forms a siphon, dipping at one end in a reservoir of ink, and at the other being shaped like a pen point, which is brought near the moving paper (the sloped section outwards). Capillary force prevents outflow when the apparatus is at rest. A fine trace is produced by this pen, without interruption by the most rapid displacements, and without sticking when at rest. M. Wolf, of the Paris Observatory, has used the system for getting records of air-pressure, temperature, wind, &c., with the best results. The reservoir needs charging only once a week; and using inks mixed with glycerine a single charge has been found to suffice for a barometer record of more than six months.

IN a recent interesting lecture, opening his course at the Collège de France, M. Ribot gave a sketch of contemporary psychology. The science in France might be characterized by one expression—"the era of monographs." There was no comprehensive work like that of Wundt in Germany; such were certainly very useful, but, like vast cathedrals, they always needed repair at some point. In psychology proper, the part belonging to logical operations, to reasoning, as principle of the unity of perceptions, had been well studied; and perhaps the most important results had been reached in the study of the nature and physical conditions of the image. The psychology of movements, especially those expressing thought, had yielded a rich harvest; while the great amount of experimentation in hypnotism, and the foundation in 1885 of a Society of Physiological Psychology (impossible twenty years ago), showed the vitality of French studies. In England, the principal contributions were in comparative psychology, represented chiefly by the work of Lubbock and Romanes. Germany was the centre of psycho-physics. Wundt's laboratory at Leipzig, founded in 1879, had acquired great renown, and, last year, had twenty students of different nationalities working in it. M. Ribot justified those studies, which had been rather depreciated in France. The predominating tendency in Italy was criminal psychology (better known as criminal anthropology)—the three chiefs of the school being Lombroso, mainly a biologist; Ferri, a sociologist and statistician; and Garofals, a jurist. It had gained several adherents in France, and there were symptoms of its invading Spain. In the United States, as in Germany, public instruction had almost alone played the part of initiation in the psychological movement; in England, the work had been chiefly done by books (Mill, Bain, Spencer, &c.). Four American Universities now gave special teaching in physiological psychology, and had laboratories, psycho-physics being the dominant study. A journal devoted to experimental psychology was started at the Johns Hopkins University, last November, by Prof. Stanley Hall. The work of James at Harvard was also referred to. Allusion was further made to Russia, which might be expected to take a good place in the psychology of the future.

THE additions to the Zoological Society's Gardens during the past week include five Pea-fowls (*Pavo cristatus*, 2 ♂, 3 ♀) from India, presented by Her Majesty the Queen; a Pagoda Owl (*Syrnium sinense*), a Horsfield's Scops Owl (*Scops lempiji*) from Penang, presented by Mr. C. B. Ricketts; three Grey-breasted Parrakeets (*Bolborhynchus monachus*) from Monte Video, presented by Mrs. Macnab; a —— Gull (*Larus* ——) from Massowah, presented by Mr. D. Wilson-Barker; a Chilian Skunk (*Conepatus mapurito*) from Chili, a Black-necked Swan (*Cygnus nigricollis*) from Australia, a White-throated Monitor (*Varanus albogularis*) from South Africa, purchased; a West Australian Great Kangaroo (*Macropus ocydromus* ♂) from West Australia, two Wandering Tree Pies (*Dendrocitta vagabunda*) from India, received in exchange; a Japaneese Deer (*Cervus sika* ♀), a Burrhel Wild Sheep (*Ovis burrhel* ♀), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 *JUNE* 17-23.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 17

Sun rises, 3h. 44m.; souths, 12h. 0m. 43·7s.; sets, 20h. 17m.: right asc. on meridian, 5h. 45·4m.; decl. 23° 25′ N. Sidereal Time at Sunset, 14h. 3m.

Moon (at First Quarter June 17, 7h.) rises, 12h. 1m.; souths, 18h. 33m.; sets, 0h. 52m.*: right asc. on meridian, 12h. 19·2m.; decl. 2° 56′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	5 37	13 43	21 49	7 27·5	21 58 N.
Venus ...	3 19	11 32	19 45	5 16·3	22 57 N.
Mars ...	13 43	19 13	0 43*	12 58·5	6 38 S.
Jupiter ...	17 36	21 59	2 22*	15 45·3	18 54 S.
Saturn ...	6 52	14 43	22 34	8 28·0	19 45 N.
Uranus...	13 23	19 3	0 43*	12 49·3	4 35 S.
Neptune..	2 27	10 12	17 57	3 56·0	18 44 N.

* Indicates that the setting is that of the following morning.

June.	h.	
18	13	Mars in conjunction with and 5° 48′ south of the Moon.
20	15	Uranus stationary.
21	0	Sun at greatest declination north; longest day in northern latitudes.
21	12	Jupiter in conjunction with and 3° 51′ south of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·4	81 16 N.	June 20,	23 14	*m*
R Virginis	12 32·8	7 36 N.	,, 23,		*m*
δ Libræ	14 55·0	8 4 S.	,, 22,	2 28	*m*
U Ophiuchi	17 10·9	1 20 N.	,, 23,	2 6	*m*
			,, 23,	22 14	*m*
Z Sagittarii	18 14·8	18 55 S.	,, 19,	1 0	*M*
			,, 23,	0 0	*m*
η Aquilæ	19 46·8	0 43 N.	,, 20,	1 0	*M*
X Cygni	20 39·0	35 11 N.	,, 22,	22 0	*m*
δ Cephei	22 25·0	57 51 N.	,, 20,	22 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near θ Ursæ Majoris	169°	55° N.	
,, ζ Cygni	318	32 N.	
Between δ and ε Cephei	335	57 N.	Swift.

GEOGRAPHICAL NOTES.

THE paper read at Monday's meeting of the Royal Geographical Society was on Hudson's Bay and Hudson's Strait as a navigable channel, by Commander Markham. It was really a brief sketch of a much larger memoir on Hudson's Bay which Commander Markham has prepared, and which will ultimately be published by the Society. For some years investigations have been carried on with a view to discover whether the navigation of Hudson's Bay could be so depended on as to justify its acceptance as a regular trade route, in conjunction with a railway, to the more northerly parts of Canada. Commander Markham briefly sketches the history of navigation in Hudson's Bay, and concludes with the results of his own visit in the summer of 1886 on board the *Alert*. The result, he states, of all the experience gathered from voyages during two centuries, and from observations at the stations, is that Hudson's Strait is perfectly navigable and free from ice in August and later in the season. It must be remembered that this passage has been successfully accomplished nearly every year for the last two centuries, while the vessels that have been employed on the service have been ordinary sailing-ships, dependent entirely on wind and weather. It is very rare indeed that they have failed to get through, and still more rare that any of them have been destroyed by the ice. It appears from the official records of the Hudson's Bay Company that Moose Factory, on the southern shore of the bay, has been visited annually by a ship since 1735, with but one exception, namely in 1779, when the vessel for once failed to achieve the passage of the strait. The percentage of losses by shipwreck among these vessels employed in Hudson's Bay is far less than would have to be recorded in a like number of ships engaged in general ocean traffic. Commander Markham pointed out that until quite recently only sailing-vessels attempted to navigate Hudson's Bay, and maintained that with a properly constructed steam-vessel, there need be neither difficulty nor danger. The establishment of new routes for commerce, Commander Markham concluded, is always a gain to the science of geography. In come cases new regions have to be discovered and explored. In others the physical aspects of an already known region must be more carefully studied, and many points of interest relating to the action of climates, or of winds and currents, may be ascertained. The proposed Winnipeg and Hudson's Bay Railroad is a striking instance. The objections of opponents to the route have had to be carefully examined. All former experience had to be collected, maturely considered, and passed in review. Observatories had to be established at several points, to make certain whether the historical records actually coincided with physical facts as they now exist. The route itself had to be sailed over and explored. All these various researches have been as great a gain to geography as to commerce. They have enriched our science with a fresh stock of information, have revised previous conceptions, and confirmed or rejected, as the case may be, the theories and views which may have been put forward. From this point of view, and from this point of view alone, can commercial or political questions receive consideration here. The study of the Hudson's Bay route involves a problem for which physical geography alone can furnish a solution.

DR. F. H. H. GUILLEMARD has been recommended, by the joint Committee of the Royal Geographical Society and the University, as Lecturer on Geography at Cambridge.

THE *Bollettino* of the Italian Geographical Society for May publishes the map of the Massawa district (Massawa to Saati) prepared to the scale of 1 : 80,000, by Prof. P. Durazzo, with the materials which have been supplied by the Italian Staff officers during the recent military operations in that region. Prof. Durazzo has also now completed his large map in two sheets, scale 1 : 800,000, of all the Italian possessions and protectorates in East Africa. These cartographic works embody the results of all the latest surveys, and contain several new features, as well as some important corrections of existing maps.

OUR ELECTRICAL COLUMN.

THE beautiful illustrations of stress in a dielectric in an electric field, due to Dr. Kerr, have been modified and amplified by Messrs. Rücker and Boys, and were shown to a large audience at the Institution of Electrical Engineers on March 22, and again at the *soirée* of the Royal

Society. The dielectric they used was carbon bisulphide (CS_2), and the beam of light passed through about four inches of the liquid. The presence and intensity of the electric field was evident to all by the brightness of the screen. They showed experiments to illustrate the fact that the repulsion of similarly electrified bodies may be regarded as an attraction between each of them and surrounding objects. They have devised an experiment visible to a large audience to show that in an electric field the structure of the CS_2 becomes crystalline—that is, the optical properties along and transverse to the electric lines of force are different; in other words, the velocities of propagation of light vibrations differ when parallel and perpendicular to the lines of force, contrary to the view formerly held on the Continent that the effect is due to unequal expansion. They were able to increase the stress so that the liquid displayed colours even to the green of the second order; and by observing the spectrum of the light passing through the field, black bands enter at the violet end and traverse its whole length as the potential rises. Faraday's experiments and speculations, Maxwell's mathematics and theories, are rapidly becoming acknowledged facts; and the apparatus of Messrs. Rücker and Boys will materially assist in spreading a knowledge of the confirmation which those theories receive from the work of Kerr and Quincke.

BLONDLOT (*Comptes rendus*, January 30, 1888) has been working in the same direction, but with vibratory discharges from a Leyden jar, in order to test the existence or non-existence of retardation in the optical effects. He could see no retardation.

COWLES's process for the production of aluminium from its ores by the direct action of an electric current of 5000 amperes in an electric furnace has now become an industry. Works have been started near Stoke, and bronzes of wonderful quality are supplied at comparatively cheap prices.

THERE is a fashion in experimental investigation as in everything else. Self-induction is played out, and now the counter E.M.F. of the arc is passing through the same phase. Uppenborn (*Beiblätter*, No. 1, 1882, p. 83) is the last inquirer. He finds for a current of 7·7 amperes and 10 mm. carbons, that $a = 35{\cdot}4$ to $45{\cdot}4$; $b = 1{\cdot}74$ to $3{\cdot}2$ in Edlund's formula—

$$E = a + bl.$$

Since a decreases both for an increase of current and for an increase in the section of arc, he leans to a resistance hypothesis rather than an E.M.F.

KLEMENCIE (*Beiblätter*, No. 1, 1888, p. 57) finds the specific inductive capacity of mica to be 6·64; Cohn and Arons (*Ann. der Physik*, No. 1, 1888, p. 13) that of distilled water 76, ethyl alcohol 26·5, amyl alcohol 15, and petroleum 2·04.

PALMIERI (March 1888) has observed that in a bright clear sky, with a high and steady barometer, and every indication of continued fine weather, the electrometer will give an indication of change long before the barometer.

W. KOHLRAUSCH (*Electrotechnische Zeitschrift*, March 1888) has estimated the current and quantity of electricity in a lightning-flash. He calculates that it will take 9200 amperes to melt a copper rod of 2·5 centimetres diameter. Preece's constant (Proc. R.S., March 1888) makes it 10244. Such a current concentrated in a flash would contain from 52 to 270 coulombs, which would decompose from 5 to 25 milligrammes of water, and from 9 to 47 cubic centimetres of explosive gas. If this energy were stored up and distributed for electric lighting, it would require from 7 to 35 such flashes to keep one glow lamp alight for an hour.

VOGEL (*Electrotechnische Zeitschrift*, January 1888) had previously calculated the relative value of copper and iron as lightning-protectors, giving iron a section 2·5 times that of copper to act with equal efficiency. Preece's constants give the relative efficiency—

Iron	3148
Copper	10244

for equal diameters—that is, an inch rod will fuse with the above currents in amperes; or, if we take the same current, say 300 amperes—

Iron	0·2086
Copper	0·095

are the diameters in inches of the wires such currents will fuse, or in the ratio 2·2 to 1; Vogel's ratio being 13·54 to 9·6. Vogel did not consider the emissivity of the surface, and therefore his results are not so accurate as Preece's experimental figures.

THAT patient worker, H. Tomlinson, has proved that the temperature at which nickel begins to lose its magnetic properties is between 300° and 320° C.; but that the rate of decrease of magnetic permeability, and the temperature at which permeability practically vanishes, vary with the magnetizing force, and hence the widely different results by different observers. Faraday made the former point 330° to 340°; Becquerel 400°; Pouillet 350°; Chrystal 400°. Iron behaves in the same way: permeability vanishes between 750° and 770° according to Ledeboer.

PROF. EWING AND MR. COWAN have been examining the magnetic qualities of nickel on the same lines as the former examined iron. They confirm Sir W. Thomson's observation that longitudinal pull diminishes magnetism to a surprising extent. Their paper in the Philosophical Transactions will be looked forward to with much interest.

Ş. ARRHENIUS (*Wiener Berichte*, xcvi. p. 831) has shown that the electrical conductivity of chloride and bromide of silver was influenced by the intensity of the rays of light which fell upon the salts. It was most intense at G of the spectrum, and is therefore an effect of light, and not of heat.

F. KOHLRAUSCH (*Wiedemann's Annalen*, No. 4, 1888) has shown that the electric conductivity of

Hard steel	is 3·3
Soft steel	,, 5·5
Wrought iron	,, 7·6

mercury being 1; while their thermal conductivities in C.G.S. units were—

Hard steel	0·062
Soft steel	0·111
Wrought iron	0·152

the ratios being the same. Hence the conditions that determine the conduction of heat and electricity are the same.

MR. C. V. BOYS's interesting magnetic and electric experiments with soap-bubbles, and his wonderful manipulative skill, remind old *habitués* of the Royal Institution how exquisitely Faraday handled soap-bubbles blown with oxygen to illustrate the magnetic character of that gas. Mr. Boys blows one bubble inside another, and, on bringing the two into an electric field, the perfect indifference of the inner one to any change of potential clearly shows that electrification is confined to the absolute surfaces of a conductor, and that it is not felt at any depth within it, however small.

WHEAT CULTIVATION.[1]

THE most interesting sections of this number of the Journal are those bearing upon the subject of wheat cultivation. The permanent wheat and barley experiments at Woburn, reported upon by Sir John Lawes, Bart., is followed by a paper upon the condition of wheat-growing in India by Dr. George Watt, Reporter upon Economic Products to the Government of India. Next comes an article by Mr. W. E. Bear upon the Indian wheat trade. Lastly, in this connection, comes a highly interesting account of modern improvements in corn-milling machinery. These four papers occupy one-third part of the volume, and taken in connection with each other throw considerable light upon the difficulties under which the English wheat-grower is struggling. Dr. Watt and Mr. Bear both show the extraordinary extent of the wheat-producing area of our Indian Empire, and the rapidity with which this vast field is being opened up. With reference to the latter point men in middle life are scarcely likely to realize the fact that in 1853 there were in all only 20½ miles of railway in India, that in 1873 there were 5695 miles of railway, while in 1887 there were 13,386 miles. Telegraphic communication with India was first opened in 1865, and the opening of the Suez Canal in 1869 was scarcely of less importance in developing her trade—first, by shortening the passage, and secondly, by mitigating the risk from wheat weevil. Another agency has been the development of irrigation works.

[1] The Journal of the Royal Agricultural Society of England, vol. xxiv. (second series), part 1. (John Murray, Albemarle Street.)

We read that "only" 30,000,000 acres have up to date been artificially irrigated, but the appropriateness of the qualifying adverb is rendered evident when it is employed in contrast with the total area of 200,000,000 acres of cultivated ground, and the vast tract of 868,314 square miles which include British India. The normal area under wheat is 26,000,000 acres, and the degree to which this area is likely to be increased depends entirely upon demand and price. Dr. Watt informs us that the Indian cultivator is at all times ready to adapt his courses of cropping to circumstances, and that he will increase or abandon the cultivation of wheat, cotton, or any other crop according to its comparative profitableness.

Dr. Watt comes to the conclusion that the Indian wheat trade up to the present time is a perfectly natural one. "The people are exporting only what they specially cultivate for that purpose. The moment better profits can be realized on another crop they will turn from wheat, without being in the least degree incommoded." If this is the case, the English farmer may well look with envy upon his Indian brother, as he is in the unfortunate position of being compelled to carry on wheat-growing from sheer inability to find a substitute for it in his agricultural economy. Natural though the course of the ryot may be from his point of view, the actual bounty upon wheat, or what amounts to a bounty, consequent upon the fall in value of the rupee, can scarcely be described as natural. This great advantage to the Indian cultivator is clearly brought out by Mr. Bear by the following considerations. First, the Indian ryot gets as much for a quarter of his wheat now as he obtained in 1872. He gets as many rupees, and his rupees are worth as much to him as they were then! In 1871–72 the average exchange value of the rupee was *1s.* 11·12*d.*, whereas recently it has been under *1s.* 5*d.* The price of No. 2 club wheat in Calcutta in 1872 averaged only *2rs.* 3*a.* 1*p.* per maund, whereas it has for some time past been over *2rs.* 10*a.*! Taking *16rs.* per quarter (6 maunds) as the price for both periods, then reckoning the exchange value of the rupee for both periods, it is clear that the exchange value of *16rs.* in 1872 was equal to *30s.* 8*d.* per quarter, whereas the exchange value of the same sum in 1888 is only *22s.* 8*d.* The fact is that the Indian ryot gets as much for a quarter of wheat now as he did in 1872, in spite of the fall in prices. He gets as many rupees, *and his rupees are worth as much to him.* This seems to settle the question as to the encouragement given to the ryot as a competitor in wheat-growing with the English farmer. Another point, in all respects discouraging to the cultivation of wheat in England, is found in the complete revolution during the last ten years in corn-milling machinery described by Mr. W. Proctor Baker, of Bristol. There has been in fact not a mere substitution of one machine for another, or of one series of machines for another, but there has been a change of the principle and mode of procedure. The old system of "low grinding" by mill-stones, so well calculated for producing flour from soft, tender wheats, such as are produced by us, has been entirely superseded by the Hungarian and American "gradual reduction" process by "roller mills." Not only does this system require the wheat to be dry, hard, and brittle, so as to secure the requisite cracking and gradual reduction, but anything in the form of a soft or moist wheat is most injurious to the machinery and the products. It rolls into a paste, steam is generated, and the flour works into balls, becomes attached to the rollers, turns sour, and, in fact, throws the entire process out of gear. "It is because of these troubles that owners of mills on a large scale will not employ native wheats in damp seasons. No concession of price is sufficient inducement to them to risk the disorganization of the mill, and probable loss of reputation, by turning out inferior or irregular flour." There are, however, two modes in which these wheats may be used. First, by submitting them to an artificial drying process; and secondly, by mixing them with some description of very brittle wheat, and allowing the mixture to lie for some weeks, until the brittle wheat absorbs some of the moisture of the native wheat, to the mutual advantange of both.

One of the most serious points at issue between science and agricultural practice at present appears to be the comparative values of farm-yard manure and artificial fertilizers. So far as absolute experiment goes, the evidence seems to be in favour of the application of the latter, while, on the other hand, the preponderating opinion among farmers is on the side of farm-yard manure. In the Report on the Field and Feeding Experiments at Woburn, by Dr. J. Augustus Voelcker, applications of dung appear somewhat at a disadvantage when contrasted with applications of salts of potash, phosphates, and nitrates direct. Mr. Vallentine, in his paper upon the practical value of dung as compared with artificial manures, declares in favour of the latter, and labours to show the extravagant cost at which farm-yard manure is produced. "For years past," he says, "my main reliance has been placed on artificial manures. Some dung is made and some bought, but it is found to answer best, as a rule, to sell hay and straw and to purchase manures." This may answer on some classes of soil; but what would be the effect upon our high-lying and thin chalk downs if we were to relinquish sheep-farming and depend upon "artificials?"

Many more valuable papers well repay perusal, among others one upon recent experiences in laying land down to grass, by Mr. James A. Caird. The remainder are mostly official in character, being the usual Reports upon implements, prize farm competitions, shows, experiments, and the Annual Reports of the Consulting Chemist, Botanist, and Entomologist, which, however, are none the less valuable for being official.

Downton. JOHN WRIGHTSON.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following are the speeches delivered on June 9 by the Public Orator, Dr. Sandys, Fellow and Tutor of St. John's College, in presenting for the honorary degree of Doctor in Science, Prof. G. G. Stokes, Lord Rayleigh, Sir Frederick Abel, Prof. Cayley, and Prof. Adams:—

(1) Salutamus deinceps Regiae societatis praesidem, professorem nostrum Lucasianum, senatorum nostrorum omnium consensu Britanniae senatoribus additum; quem in munere illo triplici Newtoni nostri in vestigiis insistere gloriamur. Atqui ipse, qua est morum suavitate et modestia, vix tali sese honore dignatur, sed a plausu populari remotus et seclusus, templum quoddam serenum occupat, ubi reverentia debita rerum naturae miracula perscrutatur, ubi "in statione tranquilla collocatus" lucis leges obscuras observat, observatas ingenii sui lumine illustrat. Viro tali rerum naturam contemplanti crediderim apparere nonnunquam sedes illas quietas,

> "quas neque concutiunt venti, nec nubila nimbis
> aspergunt, neque nix acri concreta pruina
> cana cadens violat, semperque innubilus aether
> integit, et large diffuso lumine ridet."

Duco ad vos virum illustrem, PROFESSOREM STOKES.

(2) Venio ad nomen physicorum professoris quem non sine desiderio nuper amisimus, viri cum Cancellarii nostri munificentia haud ita pridem consociati. Ex illo velut fonte, liberalitatis flumen amplum professoris nostri in provinciam defluxit inque alias Academiae partes redundavit. Ipse fontium exsilientium et aquarum destillantium naturam quam feliciter exploravit; caeli colorem illum caeruleum quam dilucide explicuit; quicquid audiendi quicquid videndi ad rationes intimas pertinet, quam sapienter interpretatus est; quotiens in rerum natura eventis specie quidem inter sese diversis causas easdem subesse ostendit. Quam profundam rei mathematicae θεωρίαν, ut aiunt, cum quanta in experimentis instituendis sollertia coniunxit; quam subtilem denique scientiae cognitionem cum sensu illo communi consociavit qui non in magna tantum fortuna sed in omni vitae condicione rerum omnium est revera ra rissimus.

Duco ad vos IOANNEM WILELMUM STRUTT, BARONEM RAYLEIGH.

(3) Scientiam Chemicam et in bello et in pace utilem esse, quis negabit? Heri in hoc ipso loco virum hunc insignem docentem audivistis, quo potissimum modo scientia illa populi saluti consulere et pericula pacis in artibus suscepta possit avertere. Idem Martis fulmina illa antiquis ignota quam familiariter tractat: pulverem illum formidolosum quo Bellona gaudet, quot experimentis vexat: quam admirabilem in modum velut Olympius ille Aristophanis, fulgurat, tonat, omnia permiscet. Atqui non minus quam Pericles ille Atheniensis, qui tot insularum imperium civitati suae conciliavit, inter ipsa tonitrua audit tot coloniarum Britannicarum uno in imperio coniunctarum vocem, et illorum consiliis pro virili parte opitulatur qui in ipsa μητροπόλει artium et scientiarum templum quoddam tanto imperio dignum consecrare voluerunt. Templi illius e sacerdotibus unum, cuius praeceptor coram Principe nostro in hoc senaculo quondam

laudatus est, hodie coram eodem, templi illius praeside illustrissimo, titulo nostro libenter ornamus.

"sunt hic etiam sua praemia laudi;
sunt lacrimae rerum et mentem mortalia tangunt."

Duco ad vos Hofmanni discipulum, Faradai successorem, FREDERICUM AUGUSTUM ABEL.

(4) Perveni tandem ad Professorem nostrum Sadlerianum, virum non modo in recentioris quae dicitur Algebrae provincia, sed etiam studiorum mathematicorum in toto regno inter principes numeratum; qui, quamquam iuris peritia honores summos adipisci potuisset, maluit sese scientiae illi dedicare, quae verbis quam paucissimis, quam illi quae verbis quam plurimis, rerum veritatem exprimere conatur. Quantum tamen prudentia eius Academiae profuerit, et senatus totius concilium et Collegium plus quam unum testantur; neque Cami tantum prope ripas sed etiam in ipsa Europa atque adeo trans aequor Atlanticum fontes eius aliis patuerunt. Idem, velut alter Socrates, ipsi rerum pulchritudini et veritati mentis oculis contemplandae sese consecravit, arbitratus illa sola quae studiorum suorum in puro velut caelo sint, revera esse, illorum autem imagines quas φαινόμενα vocamus, velut specus εἴδωλα videri; ipsam vero pulchritudinem percipi quidem posse sed non omnibus explicari. Quam dilucide tamen regnum suum quondam non campo deserto comparavit sed regioni cuidam pulcherrimae primum e longinquo prospectae, cuius partem unamquamque posse deinde peragrari, cuius et clivos et valles, et rivos et rupes, et flores et silvas posse propius maxima cum voluptate aspici. Diu, inter numina silvestria, regionem illam laetam feliciter pererret Professor noster insignis, ARTHURUS CAYLEY.

(5) Extra ipsas Athenas, stadiis fere decem ab urbe remotus, prope ipsam Platonis Academiam, surgit Coloneus ille tumulus Sophocleo carmine olim laudatus, Neptuni templo quondam ornatus, astronomi magni Metonis cum memoria consociatus. Et nos Colonum nostrum iactamus, clivum illum spatio a nobis eodem distantem, locum arboribus obsitum, avibus canorum, ubi in templo quodam stellis observandis dedicato vivit Neptuni ipsius inventor. Quid si Colono nostro deest Cephisus? sed aqua de clivo illo antiquitus deducta, Collegii Herscheliani sub hortis transmissa, Newtoni in Collegio in fontem exsilit. Quid si Neptuni inventi gloria cum altero participatur? sed, gloriae illius geminae velut imago perpetua, Geminorum in sidere est stella quaedam quae caeli totius inter stellas duplices prae ceteris fulget. Idem neque stellarum geminarum cursus, neque Saturnum neque Uranum inexploratum reliquit; neque faces illas caelestes, Leonides vocatas, quas ter in annis fere centenis orbes suos magnos conficere ostendit; neque motum illum medium lunae qui cum motu diurno terrae collatus per saeculorum lapsus paullatim acceleratur. Talium virorum laudibus non debet obesse quod inter nosmet ipsos vivunt; pravum enim malignumque foret "non admirari hominem admiratione dignissimum, quia videre, alloqui, audire, complecti, nec laudare tantum, verum etiam amare contigit."

Tot insignium virorum nominibus hodie velut cumulus accessit vir illustris, PROFESSOR ADAMS.

The Senior Wrangler of the year is Mr. Orr, of St. John's; the Second Wrangler Mr. Brunyate, of Trinity. No woman is placed with the Wranglers; but one, Miss H. F. Ashwin, of Girton, is bracketed with the first Senior Optime.

The Rede Lecture was delivered in the Senate House on Friday, by Sir F. A. Abel, on the applications of science to the protection of human life.

The Report on Local Lectures gives particulars of a large number of science lectures given in local populous centres. At evening lectures on astronomy at Northampton, Mr. J. D. McClure had a regular audience of 277, and 250 at Aylesbury. The formation of Students' Associations, for mutual aid between the lectures, has been very useful. Several students from Northumberland came up to Cambridge in the Long Vacation, and did practical work in chemistry and biology.

The Syndicate appointed to report on Sir Isaac Newton's manuscripts in the possession of the Earl of Portsmouth, the scientific portion of which he offered to present to the University, have prepared a detailed catalogue of the whole, which is to be published.

Prof. Thomson announces that students who receive permission may work in the Cavendish Laboratory in the Long Vacation. There will be a special course for those who have passed the Mathematical Tripos, and intend taking the Natural Sciences Tripos.

In the Long Vacation, Mr. Fenton will give a general course on Chemistry, Mr. Potter will lecture on Systematic Botany with practical work, Prof. Macalister will lecture on Osteology, and Mr. Wingfield will give a revision course of Practical Physiology for Dr. Foster; Prof. Roy will lecture on the Elements of Pathology, and will hold a practical course on three days a week.

Prof. Lewis will lecture on Crystallography during July, and Mr. Solly will give elementary demonstrations in Mineralogy during July and August.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. x. No. 3 (Baltimore, April).—The number opens with an article by M. E. Goursat, "Surfaces telles que la somme des rayons de courbure principaux est proportionnelle à la distance d'un point fixe au plan tangent" (pp. 187–204), in which are discussed some surfaces of a somewhat more general character than those treated of by M. Appell in the last number of the *Journal*. The title sufficiently indicates the scope of the memoir, which in part touches upon work accomplished by Riemann.—"Remarks on the Logarithmic Integrals of Regular Linear or Differential Equations" (pp. 205–24), by Karl Heun, follows up Fuchs's investigations (*Journal für Mathematik*, lxviii. p. 376). The author has elsewhere shown that the Fuchs equations are not independent of each other when the differential equation is of a higher order than the second, and in this paper he deduces, from elementary considerations, the minimum number of conditions on which the existence of logarithms depends. In addition he gives several theorems concerning the pseudo-singular points.—Mr. C. H. Chapman, in his article "On Some Applications of the Units of an n-fold Space" (pp. 224–42), obtains a proof of the rule for multiplying two determinants of the nth order by the principles of quaternions.—In "A Problem suggested in the Geometry of Nets of Curves and applied to the Theory of Six Points having Multiply Perspective Relations" (pp. 243–57), Mr. E. H. Moore discusses matters treated of by Von Staudt, Clebsch, Klein, and others.—Adopting the definition of *orientation* given by Laguerre, M. G. Humbert generalizes results previously obtained by Laguerre and himself in a memoir entitled "Sur l'orientation des systèmes de droites" (pp. 258–81), and also brings together some interesting properties of the hypocycloid given already by Cremona and Darboux.

Bulletin de l'Académie Royale de Belgique, April.—Contribution to the study of the albuminoid substances in the white of an egg, by MM. G. Corin and E. Bérard. It was recently shown by Halliburton that the albumen of the serum is a mixture of two or of three albumens, according to the nature of the animal, which coagulate under different degrees of temperature. Applying the same process of research to the albuminoids of the white of eggs, the authors find that five different albuminoid substances are present in this liquid: two globulines, coagulating at +57° and +67° C. respectively, and three true albumens, coagulating at +72°, +76°, and +82°. Besides these new facts, they also offer some interesting remarks on the general character of the relations existing between the albumens and the globulines, and on the opalescence observed when these substances begin to coagulate under the action of heat.—M. F. Folie describes a new method of determining the constant of aberration by means of a series of observations of one and the same star in right ascension. For this method he claims great simplicity, and exemption from the numerous sources of error to which other processes are liable.—To this number of the *Bulletin*, A. F. Renard contributes an exhaustive memoir on the prevailing geological formations of the Cape Verd Islands.

Rendiconti del Reale Istituto Lombardo, May.—On an old theory regarding the climate of Quaternary times, by Prof. T. Taramelli. Reference is made to the theory announced in 1840 by Lombardini, who considered that the Quaternary climate was simply a continuation of those of previous epochs, modified by the appearance of more elevated lands upheaved in post-Tertiary times. This anticipates by twenty years Frankland's remarks on the physical causes of the Glacial epoch, and leads the author to formulate a vulcanico-glacial theory based on the views of these physicists and of Charpentier.—Meteorological observations made at the Brera Observatory, Milan, during the month of April.

Rivista Scientifico-Industriale, May 15.—Remarks on the earthquake at Florence on November 14, 1887, by Prof. P. G. Giovannozzi. Following the system adopted by Serpieri, the author has collected data from various quarters showing that the disturbance was of a purely local character. The chief shock, although so violent as to have been heard by the deaf, passed through the city with such velocity that very little damage was done. It presented all the characters of a true gaseous explosion, taking a vertical direction from a moderate depth below the crust of the earth, and absolutely unconnected with any volcanic phenomena. It is noteworthy that the earthquake followed a long and exceptional period of wet weather, during which a rainfall of 225mm. was recorded within the zone of disturbance.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 17.—"On Æolotropic Elastic Solids." By C. Chree, M.A., Fellow of King's College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

On the multi-constant theory of elasticity, the equations connecting the strains and stresses contain 21 constants. As shown by Saint-Venant, these reduce for one-plane symmetry to 13, for three-plane symmetry to 9, and for symmetry round an axis perpendicular to a plane of symmetry to 5.

Part I. of this paper deals with one-plane symmetry. A solution is obtained of the internal equations of equilibrium complete so far as it goes. It is employed in solving the problem, already treated by Saint-Venant, of a beam, whose length is perpendicular to the plane of symmetry, held at one end, and at the other acted on by a system of forces, whose resultant consists of a single force along the axis of the beam, and of a couple about any line in the terminal section through its centroid. The case when the cross-section is elliptical, and the beam exposed to equilibrating torsional couples over its ends is also treated. Results are obtained confirmatory of Saint-Venant's. They are also extended to the case of a composite cylinder, formed of shells of different materials whose cross-sections are bounded by concentric similar and similarly situated ellipses, the law of variation being the same for all the elastic constants of the solution. The limiting case of a continuously varying structure is deduced.

When a beam of circular section is exposed to torsion, it is proved that warping will ensue proportional to the moment of the twisting couple. Only two diameters in the cross-section, and these mutually at right angles, remain perpendicular to the axis of the beam.

Part II. treats of a material symmetrical round an axis, that of z, and having the perpendicular plane one of symmetry. A general solution of the internal equations of equilibrium is obtained, supposing no bodily forces to act. The solution involves arbitrary constants, and consists of a series of parts, each composed of a series of terms involving homogeneous products of the variables, such as $x^l y^m z^{n-l-m}$, where l, m, n are integers, and n is greater than 3. The terms involving powers of the variables, the sum of whose indices is less than 4, are then obtained by a more elementary process, and these alone are required in the applications which follow.

The first application of the solution is to "Saint-Venant's problem" for a beam of elliptical cross-section. The problem is worked out without introducing any assumptions, and a solution obtained, which is thus directly proved to be the only solution possible if powers of the variables above the third be neglected.

Part III. consists of an application of the second portion of the solution of Part II. to the case of a spheroid, oblate or prolate, and of any eccentricity, rotating with uniform angular velocity round its axis of symmetry, which is also the axis of symmetry of the material. The surface of the spheroid is supposed free of all forces.

The limiting form of the solution, when the polar axis of the spheroid is supposed to diminish indefinitely, is applied to the case of a thin circular disk rotating freely about a perpendicular to its plane through its centre. The solution so obtained is shown to satisfy all the conditions required for the circular disk, except that it brings in small tangential surface stresses. According to this solution the disk increases in radius, and diminishes everywhere in thickness, especially near the axis, so as to become biconcave. All, originally plane, sections parallel to the faces become very approximately paraboloids of revolution.

Again, by supposing the ratio of the polar to the equatorial diameter of the spheroid to become very great, a surface is obtained which differs very little from that of a right circular cylinder. The corresponding form of the solution obtained for the spheroid, when the ratio of the polar to the equatorial diameter becomes infinite, may thus be expected to apply very approximately to a long thin cylinder. This is verified directly, and it is shown that this solution is in all respects as approximately true as that universally accepted for Saint-Venant's problem. According to the solution the cylinder shortens, and every cross-section increases in radius but remains plane.

Part IV. treats of the longitudinal vibrations of a bar of uniform circular section and of material the same as in Part II. Assuming strains of the form—

$$\text{radial} = r\psi(r)\cos(pz - \alpha)\cos kt,$$
$$\text{longitudinal} = \phi(r)\sin(pz - \alpha)\cos kt,$$

$\phi(r)$ is found in terms of $\psi(r)$ by means of the equations established in Part II. From these equations is deduced a differential equation of the fourth order for $\psi(r)$, and for this a solution is obtained containing only positive integral even powers of r. A relation exists, determining all the constants of the solution in terms of the coefficients a_0 and a_2 of r^0 and r^2. In applying this solution to the problem mentioned, terms containing powers of r above the fourth are neglected, and it is shown to what extent the results obtained are approximate.

On the curved surface, the two conditions that the normal and tangential stresses must vanish lead to the following relation between k and p—

$$k = p\left(\frac{M}{\rho}\right)^{\frac{1}{2}}\{1 - \tfrac{1}{4}p^2a^2\sigma^2\}.$$

Here ρ denotes the density and a the radius of the beam, while M is Young's modulus, and σ the ratio of lateral contraction to longitudinal expansion for terminal traction. This agrees with a result obtained by Lord Rayleigh ("Theory of Sound," vol. i. § 157) on a special hypothesis.

Proceeding to the terminal conditions, it is shown how p is determined from the conditions at the ends. Since a_0 depends only on the amplitude of the vibrations, we are left with no arbitrary constant undetermined. If the bar be so "fixed" at its ends that the radial motion is unobstructed, this leads to no difficulty, but if an end be "free" a difficulty arises. At such an end the solution requires the existence of a radial stress $\propto (2i + 1)^3 r(a^2 - r^2)/l^3$, where i is an integer depending on the number of the harmonic of the fundamental note, and l denotes the length of the bar. There will thus be a difference in these cases between the results of experiment and those of the accepted theory, even as amended by Lord Rayleigh. This divergence will increase rapidly with the order of the harmonic, and, though very small for a long thin bar, will increase rapidly as the ratio of the diameter to the length is increased. Since, in dealing with the conditions at the curved surface, terms of the order $(a/l)^6$ were neglected, the same remarks apply, though to a smaller extent, in the case of the "fixed-fixed" vibrations.

May 31.—"Investigations on the Spectrum of Magnesium. No. II." By Profs. Liveing and Dewar.

Since our last communication on this subject, we have made many additional observations on the spectrum of magnesium under various circumstances, and have arrived at some new results. Speaking generally, we find that differences of temperature, such as we get in the flame of burning magnesium, in the arc, and in the spark, produce less differences in the spectrum than we had before attributed to them. For instance, the lines which previously we had observed only in the spark discharge, we have since found to be developed in the arc also, provided the discharge occur between electrodes of magnesium.[1] In making these experiments we used thick electrodes of magnesium, and brought them together inside a glass globe about 6 inches in diameter, fitted with a plate of quartz in front

[1] Compare the appearance of the lines of hydrogen in the arc discharge. Roy. Soc. Proc., vol. xxx. p. 157; and vol. xxxv. p. 75.

and filled from time to time with various gases. The arc was an instantaneous flash which could not be repeated more than twice without rendering the sides of the vessel opaque with a complete coating of magnesium. It was therefore analogous to an explosion of magnesium vapour. The strong blue line λ4481, two pairs about λ3895, 3893, and λ3855, 3848, the strong pair about λ2935, 2927, and the two weaker lines of the quadruple group, namely λ2789·9 and 2797, all come out in the arc given by a Siemens dynamo between magnesium electrodes in air, in nitrogen, and in hydrogen. We have observed most of them also when the arc is taken in carbonic acid, in ammonia, in steam, in hydrochloric acid, in chlorine, and in oxygen. The observations render doubtful the correctness of the received opinion that the temperature of the spark discharge is much higher than that of the arc. Heat, however, is not the only form of energy which may give rise to vibrations, and it is probable that the energy of the electric discharge, as well as that due to chemical change, may directly impart to the matter affected vibrations which are more intense than the temperature alone would produce.

The Bands of the Oxide.

The set of seven bands in the green, beginning at about λ5006·4 and fading towards the violet side of the spectrum, which we have before attributed to the oxide of magnesium, have been subjected to further observation, and we have no reason to doubt the correctness of our former conclusion that they are due either to magnesia or to the chemical action of oxidation. On repeating our experiments with the spark of an induction coil between magnesium electrodes in different gases at atmospheric pressure, we could see no trace of these bands in hydrogen, nitrogen, or ammonia, whether a Leyden jar was used or not. Nor could we see them at all in carbonic oxide, but in this case the brightness of the lines due to the gas might prevent the bands being seen if they were only feebly developed. On the other hand, the bands come out brilliantly when the gas is oxygen or carbonic acid, both with and without the use of a Leyden jar. In air and in steam they are less brilliant, but may be well seen when no jar is used. When a jar is used they are less conspicuous, because in air the lines of nitrogen come out strongly in the same region, and in steam the F line of hydrogen becomes both very bright and much expanded.[1] It seems, therefore, that it is not the character of the electric discharge, but the nature of the gas which determines the appearance of the bands; and the absence of the bands in the absence of oxygen, and their increased brilliance in that gas, leave little room for doubt that they are due to the oxide, or to the process of oxidation. If a very small piece of magnesia, such as a fragment of the ash of burnt magnesium ribbon, be held in an oxy-hydrogen jet, most of the spectrum of burning magnesium is developed in the flame for a short distance from the piece of magnesia. Under these circumstances, the flame shows the *b* group and the magnesium-hydrogen series close to it, the bands in the green, the triplet near L, the triplet near M of the flame of burning magnesium, with the group of bands in that region, and the line λ2852. It is remarkable that the proportions in which the oxygen and hydrogen are mixed affect the relative intensities of different parts of the spectrum. In general, both the metallic lines of the *b* group and the bands of the oxide are easily seen; but if the oxygen be in excess the bands of the oxide come out with increased brightness, while the *b* group fades or sometimes becomes invisible. On the other hand, if the hydrogen be in excess the bands fade, and the *b* group shows increased brilliance. There can hardly be much difference in the temperature of the flame according as one gas or the other is in excess, but the excess of oxygen is favourable to the formation and stability of the oxide, while excess of hydrogen facilitates the reduction of magnesium and its maintenance in the metallic state. As regards temperature, it should be observed that while substances merely heated by the flame, and not undergoing chemical change, are not likely to rise to a temperature above the average temperature of the flame, it will be otherwise with the materials of the flame itself and other substances in it which are undergoing chemical change, and have at the instant of such change the kinetic energy due to the change.

In fact, when chemical changes are occurring in a flame it cannot be taken for granted that the temperatures of the molecules are all alike, or that the vibrations which they assume are the result of heat alone. On the other hand, the temperature of the metal separated from magnesia by the oxyhydrogen flame cannot, we suppose, be at a temperature higher than that of the hottest part of the flame. We are therefore inclined to think that the metallic lines (*b*) are manifested at a lower temperature than the bands of the oxide; and the appearance of a line in the position of the first band without any trace of the second band (which is nearly as bright as the first), and without any trace of the *b* group, is quite sufficient to create a suspicion of mistaken identity when Mr. Lockyer ascribes the sharp green line in the spectrum of nebulæ to this band of magnesia. This suspicion will be strengthened when it is noticed that the line in question is usually in the nebulæ associated with the F line of hydrogen, if it be borne in mind that the spark of magnesium in hydrogen does not give the bands, and that the oxyhydrogen flame hardly produces them from magnesia when the hydrogen is in excess.

In Mr. Lockyer's map of the spectrum of the nebula in Orion (Roy. Soc. Proc. vol. xliii. p. 134), he has represented three lines in the position of the edges of the first three of these bands. If these three lines were really seen in the nebula, there would be less room to doubt the identity of the spectra; but the authorities quoted for the map (*loc. cit.*, p. 142) mention only a single line in this position.

When the flame of burning magnesium is viewed with a high dispersion, these bands are resolved into series of fine, closely set lines. Seven such series may be counted, beginning at the approximate wave-lengths 5006·4, 4995·6, 4985·4, 4973·6, 4961·6, 4948·6, 4934·4, respectively. When a condensed spark is taken between magnesium electrodes in oxygen mixed with a little air, the pair of strong nitrogen lines may be seen simultaneously with the bands, and lying within the first band, the bright edge of the band being somewhat less refrangible than the less refrangible of the two nitrogen lines.

When the bands are produced by the spark discharge between magnesium electrodes in oxygen or other gas, we have not been able to resolve them into lines, but the whole amount of light from the spark is small compared with that from the flame, and besides it is possible that the several lines forming the shading may be expanded in the spark, and thus obliterate the darker spaces between them.

Triplet near M and adjacent Bands.

Our former account of the spectrum of the flame of burning magnesium included a description of a triplet near the solar line M, and a series of bands extending from it beyond the well-known triplet near L. As we had not observed these features in the spectrum of the spark or arc, and could not trace their connection with any compound, we concluded that they were produced by magnesium only at the comparatively low temperature of the flame. We have since found that they are not produced by the metal at that temperature only, but are exhibited as strongly, or even more strongly, in the arc between electrodes of magnesium. In the latter case they appear concurrently with the line at 4481 and other lines which seem to belong to high temperatures. We must therefore regard them as not only produced at the temperature of flames, but as persistent at temperatures very much higher.

The different circumstances under which we have observed this triplet are as follow:—

In the oxyhydrogen flame when a very small piece of magnesia is held in it. In this case the outer two lines of the triplet are much stronger than the middle line (λ3724 about), which in some of our photographs does not show at all. It should be noticed that the least refrangible of the three lines (λ3730 about) is in general more diffuse and not quite so bright as the two more refrangible lines. Magnesia in the oxyhydrogen flame also gives rise to some bands close to and more refrangible than the triplet, and to another still more refrangible but less bright triplet, in which the lines are set at nearly equal distances from each other, with the approximate wave-lengths 3633·7, 3626·2, 3620·6. These additional bands and triplets are not really absent from the flame spectrum, for traces of them may be seen in some of our photographs of the magnesium flame, but they seem relatively brighter in the oxyhydrogen flame with magnesia, and the longer exposure of the photographic plate in the latter case

[1] Neither the arc of a Siemens dynamo, nor that of a De Meritens magneto-electric machine, when taken in a crucible of magnesia, shows these bands, even if metallic magnesium be dropped into it. A stream of hydrogen led into the crucible with a view to cool it does not elicit them. When the arc is taken in the open air, and metallic magnesium dropped through it, the bands appear momentarily, but that is probably the result of the burning of the magnesium vapour outside the arc. (May 23.)

helped to bring them out. They seem to come out more strongly under the conditions which make both the green bands of the oxide and the *b* group show well.

We have not noticed the more refrangible triplet (λ3633·7 to 3620·6 about) under other circumstances, but the triplet near M is produced when magnesia is held in the flame of cyanogen burning in oxygen, in the flash of pyroxylin with which magnesium filings have been mixed, or which has been treated with an alcoholic solution of magnesium chloride.

It is not only very strongly developed, but shows strongly reversed on our photographic plates, in the spectrum of the arc from a Siemens dynamo taken between electrodes of magnesium in oxygen; and most of the accompanying ultra-violet bands of the magnesium flame spectrum are at the same time reversed. It is less strongly, but distinctly, reversed in the spectrum of the same arc taken in air, in carbonic acid gas, and in sulphurous acid gas. It appears also if the arc is taken in ordinary nitrogen unless great precautions are taken to exclude all traces of oxygen or carbonic acid, when it completely disappears. It is developed also in the flash produced when a piece of magnesium ribbon is dissipated in air by the discharge through it of the current from 50 cells of a storage battery. Also in the spark in air at atmospheric pressure between magnesium electrodes connected with the secondary wire of an induction coil when the alternating current of a De Meritens magneto-electric machine is passed through the primary.

In two cases, but only two, we have found this triplet, or what looks like one or both of the more refrangible of its lines, developed in vacuous tubes. In both tubes the gas was air. One had platinum electrodes and a strip of magnesia from burnt magnesium disposed along the tube; the other had fragments of the Dhurmsala meteorite attached to the platinum electrodes. The discharge was that of an induction coil worked in the usual way without a Leyden jar. In each case it is only in one photograph of the spectrum that the lines in question appear. In other photographs taken with the same tubes they do not show.

On the other hand, this triplet does not make its appearance in the arc from a dynamo between magnesium electrodes in hydrogen, coal gas, cyanogen,[1] chlorine, hydrochloric acid, or ammonia; nor in the arc from a De Meritens machine in hydrogen or nitrogen. It does not show in the spark between magnesium electrodes of an induction coil used in the ordinary way, either with or without a Leyden jar, in hydrogen or in air at atmospheric pressure; nor in the glow discharge in vacuous tubes with magnesium electrodes when the residual gas is either air, oxygen, hydrogen, carbonic acid gas, or cyanogen. Nor does it appear, except in the one instance above-mentioned, in the glow discharge in highly rarefied air in a tube containing either magnesia or a strip of metallic magnesium.

A review of all the circumstances under which the triplet near M and its associated bands appear, and of those under which they fail to appear, leads pretty conclusively to the inference that they are due not to merely heated magnesium but to the oxide, or to vibrations set up by the process of oxidation.

We have expended a vast amount of time and trouble over vacuous tubes, and our later experiments do but confirm the opinion which we had previously formed that there is an uncertainty about them, their contents and condition, which makes us distrustful of conclusions which depend on them. Photographs of the ultra-violet spectra given by such tubes tell tales of impurities as unexpected as they are difficult to avoid. Every tube of hydrogen which we have examined exhibits the water spectrum more or less, even if metallic sodium has been heated in the tube, or the gas dried by prolonged contact with phosphoric oxide. Indeed the only tubes which do not show the water spectrum have been filled with gases from anhydrous materials contained in a part of the tube itself; and even when tubes have been filled with carbonic acid gas from previously fused sodium carbonate and boracic anhydride the water spectrum is hardly ever absent. The last traces of the ultra-violet bands of nitrogen are almost as difficult to be rid of with certainty. Frequently, unknown lines or bands make their appearance, and the same tube will at different times exhibit wholly different spectra. This is especially the case with tubes of rarefied gases which oppose much resistance to the passage of the electric discharge, such as oxygen.

The ultra-violet magnesium lines which we have observed in vacuous tubes with magnesium electrodes, when the induction coil, without jar, is employed, are the triplets at λ3837, and the lines λ2852, 2802, and 2795. These appear whether the residual gas be air, oxygen, hydrogen, or carbonic acid. When a jar is used we have obtained also the triplets at P and S, the pair about λ2935 and 2927, and the quadruple group near λ2802 and the quintuple group beyond, and *in one case only*, in oxygen, the group near *s*, described below, and the flame-triplet near M. When no jar is used sometimes only λ2852 is to be seen, sometimes λ2852 and the strong pair near λ2802, and sometimes also the triplet near L. We infer, therefore, that this is the order of persistency of these lines under the circumstances.

Group near "s."

In their list of lines in the spectrum of magnesium (Phil. Trans., 1884, p. 95) Messrs. Hartley and Adeney have given two lines, λ3071·6 and λ3046·0, which we had not heretofore observed either in the spectrum of the flame, arc, or spark of magnesium; but in our recent observations we have noticed in many cases a well-marked line which, by interpolation between neighbouring iron lines, appears to have a wave-length about 3073·5, and a pair of narrow bands sharply defined on their less refrangible sides at wave-lengths about 3050·6 and 3046·7, and fading away on their more refrangible sides.

The circumstances under which this group is seen and is not seen, do not seem to indicate that its emission is connected with any particular temperatures so much as with the character of the electric discharge, and perhaps also with the density of the magnesium vapour.

Royal Microscopical Society, May 9.—Dr. C. T. Hudson, President, in the chair.—The President said that on the occasion of his taking the chair for the first time, he desired, before beginning the business of the evening, to thank the Fellows very heartily for the honour which they had done him in electing him their President.—Mr. Crisp exhibited a form of camera lucida by M. Dumaige, of Paris, fitted in a box with a cover, which, when closed, kept the prism and mirror free from dust; also by the same maker, an adapter with spiral springs, for rapidly changing objectives, and a portable microscope in which the foot and stage were in one piece.—Dr. Kibbler exhibited and described a new stand and camera, which, he believed, would be found very useful for photomicrography. It had been made to his design by Mr. Bailey, his idea being that it was best not to take negatives upon a large plate, but on a quarter-plate first, and afterwards to enlarge the pictures from the original negatives. The great advantage of this method was in the amount of light gained for the purpose of focussing. The quarter-plate size was also the proper one for lantern slides. The ordinary diaphragm plate placed immediately below the stage he had found entirely useless, but by removing it a certain distance from the object it then ceased to cut off the field, and began to reduce the light and to improve the penetration and definition. With high powers this answered very well, but it would not work with low powers unless the diaphragm was removed to a distance too great to be convenient in practice. He had therefore devised the plan of introducing a short $1\frac{1}{2}$-inch condenser behind the stage, and about 3 inches in front of the diaphragm plate, in this way throwing it out of focus. The effect of this was that the same improvement in penetration and definition was obtained, but on a much shorter distance. Attention was also called to a method of clamping the object in position when the focus had been obtained; also to a plan for obtaining a fine adjustment by a tangent screw.—Mr. Mills's note on a sponge with stelliform spicules was read.—Mr. Crisp referred to some comments which had recently been made in America upon the advantages of the method of tilting the stage of the microscope as a means of obtaining a very economical and simple fine adjustment, on which some discussion took place.—Dr. A. C. Stokes's paper on new Infusoria Flagellata from American fresh-waters, containing descriptions of twenty new species, was read.—A paper on the Foraminifera of the Red Chalk, by Messrs. H. W. Burrows, C. D. Sherborn, and Rev. G. Bailey, was also read.

[1] In taking the arc in this way in cyanogen our photographs show the whole of the five bands of cyanogen between K and L well reversed. We have before noticed (Roy. Soc. Proc., vol. xxxiii. p. 4) the reversal of the more refrangible three of these bands against the bright background of the expanded lines of magnesium when some of that metal was dropped into the arc between carbon electrodes, but in taking the arc between magnesium electrodes in an atmosphere of cyanogen the bright wings of the expanded magnesium lines near L extend beyond the cyanogen bands, and the whole series of the latter are well reversed. (May 23.)

Paris.

Academy of Sciences, June 4.—M. Janssen, President, in the chair.—On the equilibrium of a heterogeneous mass in rotation, by M. H. Poincaré. This is a generalization (worked out on a fresh basis) of M. Hamy's theorem of fluids in rotation. If all the surfaces of the several liquid layers in contact were ellipsoids, then all these ellipsoids would be homofocal, which is impossible unless all the layers be assumed of equal density. —On the rainbow, by M. Mascart. The results are here published of the author's researches on this phenomenon in connection with M. Boitel's recent communication on the supernumerary arcs of the rainbow.—Experimental researches on the action of the brain, by M. Brown-Séquard. The experiments with rabbits here described tend to show that the so-called motor centres and the other parts of one hemisphere of the encephalon may determine movements in both sides of the body through the influence of gravitation alone. This conclusion, while opposed to the generally accepted doctrines, is in harmony with the views advocated by M. Brown-Séquard in previous communications to the Academy. It is evident, he remarks, that the motor zone of each side of the brain is capable of producing movements in the corresponding members on either side, and not, as is commonly supposed, on that side alone which is opposed to the centre of irritation.—Observations of Sawerthal's comet made at the Observatory of La Plata with the Gautier 0·217m. equatorial, by MM. Beuf, MacCarthy, Salas, and Delgado. These observations cover the period from March 9 to April 2, 1888, and the position of the Observatory is given at lat. $-34° 54' 30''·3$, long. W. of Paris 4h. 0m. 58s. —Determination of the ohm by M. Lippmann's electrodynamic method, by M. H. Wuilleumier. The true value of the ohm as worked out by this process is given by the relation $\frac{106 R'}{R}$, the resistance of the conductor between two given points A and B being $R = 0·301889 . 10^9$. The value thus obtained is represented by the resistance at 0° of a column of mercury with section 1mmq. and length 106·27cm.—On electro-chemical radiophony, by MM. G. Chaperon and E. Mercadier. By the method here adopted, the authors have succeeded in obtaining an electro-chemical radiophone whose effects are analogous to those of the selenium electric instruments, possessing equal intensity and being capable of like applications.—On the action of the alkaline phosphates on the alkaline earthy oxides, by M. L. Ouvrard. The author has made a comparative study of baryta, lime, and strontian, for the purpose of determining the nature of the compound substances that may be obtained by fusion of these bases and some of their salts with the alkaline phosphates.—On some new gaseous hydrates, by M. Villard. To those already known the author now adds analogous hydrates of methane, ethane, ethylene, acetylene, and protoxide of nitrogen. They are generally less soluble, less easily liquefied, than those previously obtained, and are decomposed at the respective temperatures of 21°·5, 12°, 18°·5, 14°, and 12°. It is shown in the case of methane and ethylene that a gas may form a hydrate above its critical temperature of liquefaction, and that these two gases have a critical temperature of decomposition considerably higher than the others.—Contribution to the study of the ptomaines, by M. Oechsner de Coninck. Having recently obtained a ptomaine in $C_8H_{11}N$, the author here determines by analysis a certain number of salts, and describes the preparation of the chloromercurates and iodomethylate.—On the development of the grain of wheat, by M. Balland. It results from these studies that wheat may be advantageously reaped eight or ten days earlier than is customary. During this latter period the grain ceases its independent growth, and may continue to complete its development just as well in the cut ear as on the standing stalk. The point is obviously of great importance to growers, who have thus so much more time to harvest their crops.—Influence of the organic temperature on convulsions produced by cocaïne, by MM. P. Langlois and Ch. Richet. Some experiments are described tending to show that the higher the temperature of the animal the more susceptible it becomes to the toxic effects of cocaïne. It is inferred that refrigeration should be a general method apt to diminish the effects of toxic substances causing convulsions.—On the chemical action and vegetative alterations of animal protoplasm, by M. A. P. Fokker. Continuing his already-described experiments, the author here shows that, besides the property of producing fermentations, protoplasm possesses that of undergoing vegetative changes, thus confirming his already expressed opinion that the formation of hematocytes is a case of heterogenesis.

Stockholm.

Royal Academy of Sciences, June 6.—A review of the researches on the electricity of the air, by Prof. Edlund.—Researches on the elasticity and tenacity of metallic wires, by Dr. Isberg.—On the probability of finding large numbers in the development of irrational decimal fractions and of continued fractions, by Prof. Gyldén.—Researches on a non-linear differential equation of the second order, by the same.—On the forms and varieties of the common herring, by Prof. F. A. Smitt.—On the integration of the differential equations in the N body, problem iv., by Prof. Dillner.—New remarks on the genus Williamsonia, by Prof. A. G. Nathorst.—Contributions to the knowledge of the hydroids of the western coast of Sweden, by M. Segerstedt.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Poems in the Modern Spirit: C. Catty (Scott).—Rural Water Supply: C. L. Hett (Spon).—Contribution à la Météorologie Electrique, Notes: Prof. J. Luvini (Turin).—Natural History Transactions of Northumberland, Durham, and Newcastle-upon-Tyne, vol. ix. Part 2 (Williams and Norgate).—Morphologisches Jahrbuch, 13 Band, 4 Heft: C. Gegenbaur (Williams and Norgate).—Bulletin of the New York State Museum of Natural History, No. 3 (Albany).—Rapport Annuel sur l'Etat de l'Observatoire de Paris, 1887 (Gauthier-Villars, Paris).—Archives Italiennes de Biologie, Tome 9, Fasc. 3 (Loescher, Turin).—Zeitschrift für Wissenschaftliche Zoologie, 46 Band, 3 Heft (Williams and Norgate).—Botanische Jahrbücher, Neunter Band, 5 Heft (Williams and Norgate).—Geological Magazine, June (Trübner).—Journal of the Society of Telegraph-Engineers and Electricians, No. 73 (Spon).—Proceedings of the Bath Natural History and Antiquarian Field Club, No. 3, vol. vi. (Bath).—Hand-book of the Amaryllideæ: J. G. Baker (Bell).—Elementary School Atlas: J. Bartholomew (Macmillan).—A Season in Sutherland: J. E. Edwards-Moss (Macmillan).—The Encyclopædic Dictionary, vol. vii. Part 1 (Cassell).—Teoría Elemental de las Determinantes: F. Amorétti and C. M. Morales (Biedma. Buenos Ayres).—The Clyde from its Source to the Sea: W. J. Millar (Blackie).—General Physiology: Dr. J. G. M'Kendrick (MacLehose, Glasgow).—An Illustrated Manual of British Birds, Part 3: H. Saunders (Gurney and Jackson).—Die Natürlichen Pflanzenfamilien, 18 and 19 Liefg.: Engler and Prantl (Leipzig).—Ueber Kern- und Zelltheilung im Pflanzenreiche (Heft 1 of Histologische Beiträge): E. Strasburger (Fischer, Jena). —Sea-side and Way-side Nature Readers, No. 2: J. M. Wright (Heath, Boston).—Report on a Part of Northern Alberta and Portions of Adjacent Districts of Assiniboia and Saskatchewan: J. B. Tyrrell (Dawson, Montreal). —The Forest Flora of South Australia, Part 8: J. E. Brown (Adelaide).—Journal of the Chemical Society, June (Gurney and Jackson).

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