THURSDAY, SEPTEMBER 22, 1892.

A 5-SENSATION THEORY OF VISION.

Color Vision. By E. Hunt. (Glasgow: John Smith and Son, 1892.)

THE author entitles his work, "An essay discussing existing theories, explaining views hitherto incompletely published, and comprising illustrated descriptions of important new experiments." We shall now proceed to see how the promise conveyed by the title is fulfilled. In the early pages of the book he makes the statement that there are five colours which are distinct sensations, viz., red, yellow, green, blue, and purple. The last, however, he is rather less certain about as conveying his meaning, but finally adopts the name after explaining what he designates by purple. These are the five colours of a 5-colour theory which he propounds, all other colours being mixtures. He has felt, however, that it is no use to bring forward a theory unless he demolishes those other theories which block the way. His examination of these last is chiefly confined to that of Young, which accounts for colour-vision on the assumption that there are only three colour sensations—a number which is a minimum when the fact is remembered that all colours can be produced by a simple colour, or by a mixture of two or three of the colours which are considered to be primary colours. His criticism of the theory is mostly confined to a paper published by Clerk Maxwell thirty years ago, and he scarcely refers to any evidence in its support which has been brought to light in more recent years. Mr. Hunt has entangled himself in mixing up colour and colour sensations together, and has forgotten that in Clerk Maxwell's papers three colours were chosen empirically as approaching the colours which are perceived when the three fundamental sensations are stimulated. Later work has shown that the colours thus shown are not representative of the fundamental sensations. No one, for instance, would say that any green in the spectrum was the colour evoked by the stimulation of the green fundamental sensation, for it is well known that, according to the theory, at every part of this region of the spectrum all three sensations are stimulated, and the nearest approach that a retina possessing normal sensations could make to perceiving this one sensation, would be when the colour evoked was mixed with a percentage of white, rendering the colour impure. We may here parenthetically remark that it is too late for Mr. Hunt to quarrel with the designations of the colour constants, for they are accepted terms. "Impure," for instance, may be an objectionable term to apply to a colour when mixed with white, but as what is meant by it is understood, it can only be used in that sense. The position of the colour which stimulates only the red fundamental sensation is fairly well known, being near to the red lithium line. The position of the colour which stimulates the violet fundamental sensation is still not absolutely settled, but it cannot be very far from the G line of the solar spectrum. Moreover, recent researches show that at the extremities of the spectrum only a red or a violet sensation is stimulated, any change in colour observed being due to a slight admixture of white light, which is derived from the imperfect transparency of the prisms or reflecting surface of the grating. The colour, for instance, near G, when mixed with a small percentage of white light, in excess of that already mixed with it, takes a violet hue, a colour which is associated with the most refrangible part of the spectrum. As the luminosity of this part is very much less than that near G, the extra percentage of white light required to form this hue is always present. The colour of any ray of the spectrum can be almost entirely freed from the white light derived from the prism by placing another prism in the path of such rays, after passing through a second slit. In an eye-piece or on a screen, the ray will be seen as a well-marked line lying in a faint continuous spectrum. Again, the references to the sensations stimulated in the various types of colour-blind people are not described in any detail, though the evidence which is derived from an examination of their vision is of the greatest importance for the Young or any other theory. The author gives most undue weight to colour diagrams. Colour triangles or circles are not intended to be the basis of a theory, but simply as illustration of it. It is quite possible that Clerk Maxwell's diagrams would not tally with those based on Kœnig's observations, nor should they do so. In fact a diagram may be drawn to illustrate any theory, as the author himself has done to illustrate his own.

In animadverting on Clerk-Maxwell's colour equations, the author, it may be remarked, has himself made a mistake as regards certain reductions to be given to the intensities of different colours. The equations are right as they stand, when it is remembered that Maxwell chose to adopt certain arbitrary units which he carried throughout them all.

The author in one place endeavours to prove the superiority of a 5-colour theory over a 3- or 4-colour theory, by narrating what is seen when a spectrum is formed with—what comes to—a very wide slit to the collimator. Practically he shows that this wide slit may be supposed to be made up with narrow slits, and that the spectrum formed when the wide slit is used is made up by the overlapping of the spectrum formed from the narrow slits. He then adds up the colours (or colour sensations) as follows:—

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R—G—P
   R—G—P
      R—G—P
         R—G—P
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R—y—W—W—b—P
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With the 4-colour theory he has five rows for addition, and with the 5-colour theory he has six rows. The last gives as the result R—2O—3Y—4b—W—W—4pe—3B—2v—P, where red, orange, yellow, lemon, white, peacock, blue, violet, and purple are denoted by the letters used as the sum of the additions. He remarks "that the results obtained for the 3-colour and 4-colour theories do not agree with what is actually seen with a prism." We can well believe it! But why he confines the colours to be added up to the number of colours in the theory we are at a loss to understand. It may be taken for granted that in employing this method of proving a theory, that theory which annexes the greatest number of primary colours will give results which are closer to what is seen than even the 5-colour theory.

As to the experiments which are "new and important," there is no doubt that there is one which will prove to be highly important if it can be always repeated to give the same results under conditions which bear rigid examination. The experiment is described as follows:

"Very many years ago I showed experiments with rotating discs, which proved that 'persistence' does not (at any rate, wholly) take place in the way previously supposed; in the retina, or in the individual parts sensitive, as I maintain, variably sensitive, to light and colours. In one of the experiments I refer to, a brightly coloured disc was covered by a black disc having sector-shaped openings, such as to render the entire disc area half black and half coloured. When the discs are rotated at a suitable speed, under a strong light, the entire rotating disc appears more brightly coloured than an entire disc placed near the rotating disc. Thus, the colour effect of a disc, half of which is covered by black sectors, is by rotation made equal to or greater than that of an entirely uncovered disc of the same colour."

This one experiment would have caused a good deal of anxiety to those who have been at work at the general theory of vision had they known of it. Fox Talbot, Plateau, and others would have had to amend their papers—for the "persistence of vision" would evidently not obey the law which they adopted after submitting it to such experimental proofs as they could devise. Other experiments which the author brings forward as confirmatory of the 5-colour theory, it seems to the writer can be equally well explained by the 3-sensation theory, and probably by that of Hering.

In conclusion, it seems safe to say that these two last rival theories have not been overthrown by the work under review. Both have their weak points, but the number of them has not been increased by the exponent of the 5-colour theory.

ELECTRICAL RULES AND TABLES.

A Pocket-book of Electrical Rules and Tables. By John Munro, C.E., and Andrew Jamieson, M.I.C.E., F.R.S.E., &c. Eighth Edition, Revised and Enlarged. (London: Griffin and Co., 1892.)

JUST eight years ago we reviewed the first edition of this electrical *vade mecum.* The fact that we have now to notice the eighth edition is abundant proof that it has been found of service by the electrical public. That it deserved well of those for whom it was compiled there can be no doubt. The authors have been most active in collecting information from all sources, and in extending the work so as to keep the information contained in it fairly representative of the current state of industrial electricity. Since the first edition it has been almost doubled in size, and much very important matter has thereby been added.

A special feature of the book as it now stands is the short accounts of various branches of electrical engineering which have been contributed by specialists. Such are Dr. Thompson's chapter on dynamo machinery, Mr. Kapp's account of transformers, and Prof. Ewing's sketch of magnetic measurements. These are very valuable, and add much to the authoritative character of the work as a guide to engineers more especially concerned with electric lighting and transmission of power.

When the first edition appeared we noticed a number of points in which we thought the book required amendment. Looking over the present edition, we have been struck with the very considerable improvement which has been effected in point of precision and accuracy. But we have again met with some passages in which we fancy the work may be still further improved.

First, on p. 10, we were not able to see before, and we do not see yet, what the fact that the dimensions of resistance in electromagnetic units are those of velocity, has by itself to do with the velocity v, which is the ratio of the electromagnetic to the electrostatic unit of quantity of electricity.

At p. 15 it might have been well to mention the convergence of all the latest absolute determinations of the ohm upon something like 106·3 cms. as the length of the column of mercury, representing it according to the usual specification.

At p. 42 definitions of the pound avoirdupois and standard kilogramme are given, in which the precise temperature and pressure of the atmosphere at which the weights of the standard lumps of platinum are a pound and a kilogramme respectively are carefully specified! We should like to know why there is not a reference to the hygrometric state of the atmosphere as well!

With regard to the statement with respect to density, at p. 43, it is not usual, we think, to define density otherwise than as mass per unit of volume. It is therefore a quantity of dimensions ML^{-3}, whereas specific gravity is a mere numeric. In cases in which specific gravity and density are numerically the same, there is still this essential difference in nature between the two quantities.

Of course, the same word *density* is used in a peculiar sense, frequently, when applied to gases, and our experience shows that nothing has a more confusing effect in the mind of an elementary student of physics and chemistry than this double use of the word. It would be well to insist, as is often done by careful teachers, that it is *relative density* that is here meant, and not density in the ordinary sense.

With respect to the velocity of sound in air (p. 50) it might be as well to notice that it depends upon the temperature of the air.

At p. 127, under the heading "Impedance," impedance in its proper technical sense as $\sqrt{R^2 + n^2L^2}$ is not defined. The definition is given elsewhere in the book, but there is no clue to it in the index. In the last formula the exponential ϵ has fallen out from before its exponent. Here we might remark that in a book of this kind, where space is of great importance, and especially with such lumbering exponents as $-\frac{RT}{L_s}$ the use of the *solidus* notation would be a great improvement.

The authors will not think us inappreciative in making these remarks. In a work dealing with such a multifarious set of topics it is difficult even in several editions to completely eliminate error, and we have made these notes (and some others) in case the authors may care to make use of them. As we have said, the book is a useful and handy synopsis of electrical information of all kinds, and is very worthy to take the place which it seems is being accorded to it, of the electrical *Molesworth.*

G.

THE MOTHS OF THE WORLD.

A Synonymic Catalogue of Lepidoptera Heterocera (*Moths*). By W. F. Kirby, F.L.S., F.E.S., &c. Vol. I. Sphinges and Bombyces. (London: Gurney and Jackson, 1892.)

THE publication of the first volume of Mr. Kirby's Catalogue of Heterocera cannot fail to be regarded as a great event amongst students of exotic moths, and should mark an epoch from which is to commence the great work of reducing the vast amount of material they have to deal with to some kind of system and order, from the state of chaos produced by the greater number of those who have taken up the subject continuing to describe innumerable species, forms, and varieties, without any systematic study or attempt to define the limits of the families and genera they placed them in. So vast and scattered was the literature on the subject that it was almost hopeless to attempt to discover even how many species had been described in any given genus, or to say with any certainty that the forms to be dealt with had not been described by other authors; and if the subject in hand was the study of a local fauna, and not the monographing of a group, the only plan it was possible to adopt was to place the species in approximately the right genus and trust more or less to chance, according to the availability of large collections for consultation, that they had not been described elsewhere.. Students will now have no such excuse for inexact work, and, up to the end of the numerous and very remotely connected groups of families known as the Bombyces, will have a complete and easily consulted catalogue of all described species, with the localities they come from, so that they will be able to see at a glance to which species the forms they are trying to identify are most likely to belong, and having full references to the books in which they are described their labours will be lightened by almost half, as students of the European fauna who have had Staudinger's catalogue to help them will fully appreciate. No one but Mr. Kirby who has lived his life among the books on the subject, and has been collecting his materials for the last twenty years, as he tells us in his preface, could have made the catalogue as complete as he has done, and though it is of course impossible that such a volume could have been put together without a few errors and omissions creeping in, yet some months of work with the advantage of being constantly able to borrow the proof sheets has shown how extremely few these are.

As the arrangement adopted is in the main that of the British Museum, or of some well known and approved works on special groups, and as there is also an index to the genera, there should be no real difficulty in finding the species required; and since the complete index to species and genera will take up one out of the five volumes required to complete the catalogue, it is obviously impossible that there should be a specific index to each volume. It is to be hoped that Mr. Kirby will be able to bring out the other volumes within the next two or three years, and will receive the support of all those interested in the subject. This, indeed, he can hardly fail to do, as they will find themselves quite unable to get on without his catalogue when once accustomed to the use of it. The marking of the type of each genus by an asterisk is an addition of very great value, as compared to the catalogue of Rhopalocera by the same author; and the only serious fault to be found with the book is the upsetting of many well-known names by the adoption of Hübnerian genera, and in especial those of the "Tentamen," a mere hand-list of names for that author's private use, and never published or intended to be published, and in accepting which Mr. Kirby will find hardly a single lepidopterist to follow him. Hübner's "Verzicknitz" stands on rather different grounds; but even that work is merely a childish collection of names, the species being classified into very heterogeneous groups solely by colour and pattern, and since the divisions which subsequent authors have been pleased to term his genera, though that name might equally well be applied to other of his sections, are neither defined nor the types indicated, it is placed out of Court according to the British Association rules; then again a few well-known generic names, such as *Cossus*, are upset as having previously been used in a specific sense. If these principles were adopted and pushed to their logical conclusion every family of Rhopalocera would have to be re-named and innumerable other changes made, so that nomenclature would be vastly more confusing than it is even now, and the whole subject made unintelligible except to the few who had leisure to make a special study of it. The classification adopted is in the main admirable; the *Castniidæ*, however, should perhaps be placed much lower in the scale; the *Uraniidæ* are rightly disassociated from the *Geometridæ*, of which they have hitherto been placed as a subfamily, but a better arrangement would have been to have included in the family the genus *Micronia* and allies, and to have placed it next to the *Epiplemidæ* (*Erosiidæ* auctorum) and the *Geometridæ*; but these are facts of very recent recognition. The *Agaristidæ* again would come better next the *Noctuidæ*, from which they are hardly separable, and the *Syntomidæ*, which Mr. Kirby calls the *Zygæninæ*, are more usually separated from the *Zygænidæ*, of which the *Chalcosiinæ* and *Thymarinæ* are considered sub-families. Then again the *Lithosiinæ Nyctemerinæ* and the *Nycteolinæ* (here called *Cymbidæ*) are at most sub-families of the *Arctiidæ*; and the *Sphingidæ*, which are very rightly placed next the *Notodontidæ*, should have been preceded by a family composed of the genus *Eupterote* and allies which are still confounded with the *Lasiocampidæ*, a family with which they have little or nothing in common. All these, however, are matters of very secondary importance, and the catalogue amply fulfils the one thing required of it that it should be as complete and the references as correct as possible.

G. F. H.

OUR BOOK SHELF.

Grasses. By C. H. Johns, M.A. 96 pp. (S.P.C.K.)

THIS is a separately published appendix to the late Rev. C. H. Johns's "Flowers of the Field." In its present handy form it will be acceptable to students who wish to study more minutely our common grasses.

The first three pages are devoted to general remarks on Order Gramineæ. On p. 3 a list of the best fodder grasses of Europe is given; *Alopecurus pratensis*, a very valuable and generally useful grass, is omitted, whilst

Cynosurus cristatus is included. This latter species is of limited value, and in permanent pasture only.

Genera are given pp. 4-11, and the following fifty pages are occupied by an account of those species which have up to the present been found in Great Britain or Ireland. The rest of the book is devoted to the sedges. The derivations of the names of genera are mostly given, as well as the French and German synonyms of the different species discussed. The illustrations are satisfactory, and are in general given for those species which are most common. That of *Triticum repens*, on p. 32, is perhaps exceptional. The beginner very often confuses the spike of this grass with that of some varieties of rye-grass. The spikelets of the latter are set edgewise to the rachis, whilst those of the former have their flat sides to the rachis; if the beginner is still in doubt the rootstock can be examined; this is stoloniferous in the case of couch-grass.

Elementary Plane Trigonometry. Clarendon Press Series. By R. C. J. Nixon, M.A. (Clarendon Press, Oxford, 1892.)

THE author in his preface informs us that in writing this book he has tried to free his mind as far as possible from all current text-books, and to base this one solely on his experience of twenty-five years. That he has done this is soon seen when glancing through the pages, for the order of arrangement and general basis differ very considerably from those usually adopted. The line of demarcation he draws between elementary and higher works lies in the use and non-use of the symbol $\sqrt{-1}$, thus avoiding here altogether the use of imaginaries. An omission which may seem rather questionable is that of the theory of logarithms, which is here excluded as it does not appertain to trigonometry proper; the beginner is not left entirely without logarithms themselves, for there are two chapters in which he can make a slight acquaintance with them, together with one on the adaptation of formulæ to logarithmic calculation. Throughout the work the author has made a strong point of giving in their fulness and generality all definitions and proofs, while he has added also numerous examples, some of which are worked out to serve as specimens, while others are accompanied with hints as to their solution.

If any fault be found in the book it is perhaps that it has been expanded to too great dimensions: excluding the answers at the end there are no less than 364 pages, which, for an elementary work of this kind, is undoubtedly a large number. At any rate the error is made on the right side. In all other respects the book can be decidedly recommended, for the propositions are all neatly proved, and the get-up, as regards the figures and letters, could scarcely be surpassed.

Paraguay: The Land and the People, Natural Wealth and Commercial Capabilities. By Dr. E. de Bourgade La Dardye. English Edition. Edited by E. G. Ravenstein. (London: George Philip and Son, 1892.)

EVERY one who has any reason to be interested in Paraguay ought to read this book, which is in most respects a model of what such a work ought to be. The author spent two years in the country, so that he had ample opportunities for making himself acquainted with its leading characteristics. His impressions, upon the whole, were very favourable; but there is not the faintest attempt to convey an exaggerated idea either of Paraguay's resources or of the use she is making of them. M. de Bourgade writes in a spirit of scientific impartiality, bringing out the facts exactly in accordance with what he believes to be the most trustworthy evidence. He begins with an account of the geographical exploration of the country, then presents a geological survey, and describes the basins of the Parana and the Paraguay, and Paraguay's vegetable and animal life and minerals. Next there are chapters on various aspects of social life—government, and laws, financial position, real property, population, and immigration. A section on "Labour" includes chapters on means of communication, the soil, stock-breeding, agricultural products, tobacco, timber, textile plants, various raw materials, yerba-maté, and the orange. On all these subjects the author writes clearly and with full information. The work is enriched with a map and illustrations, and of the translation we need only say that it has been done carefully and adequately.

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.*]

Thunderstorms and Sunspots.

ABOUT six years ago Prof. von Bezold laid before the Bavarian Academy a memoir relating to lightning-flashes that had done damage to houses in Bavaria. In that kingdom the fire-insurance of buildings is entirely in the hands of the State, and a long series of statistical data on the subject was available.

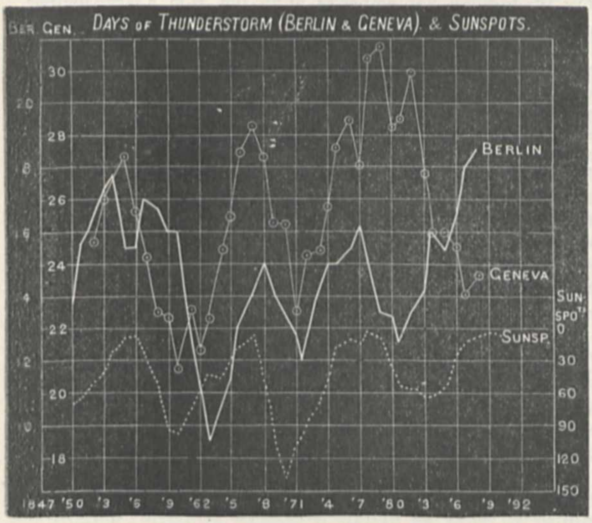
Two things appeared from this inquiry—first, that those damaging lightning-flashes had enormously increased in the last fifty years (to 1882), much more than the increase of houses; and second, that there was apparently some relation between the phenomena and the sunspot cycle. To each maximum of sunspots corresponded a minimum of damaging lightning-flashes or thunderstorms (only in two cases one year displaced); but between each pair of minima was another secondary minimum not far from the minimum of sunspots. The curve of lightning damage, in fact, shows a double oscillation for each sunspot period, maxima of sunspots corresponding with the better-defined of the two minima of lightning damage. A somewhat similar result had been arrived at by Prof. Fritz from a study of thunderstorms in the Indian Archipelago, but he considered it adverse to the idea of a causal relation between sunspots and thunderstorms.

In an earlier paper to the Bavarian Academy (1874), Prof. von Bezold, from a study of several thunderstorm records, came to the conclusion that "high temperatures and a spotless solar surface give years abounding in thunderstorms." This supposed relation between sunspots and thunderstorms does not seem to have attracted much attention of late years. The object of this note is chiefly to show some curves and figures from thunderstorm records, which, it appears to me, yield further evidence of the relation.

In the diagram herewith are two curves, one for Berlin from 1850, the other for Geneva from 1852. The numbers of days of observed thunder are taken and grouped in averages, each yearly point of the curve representing an average of five years. The vertical scale-figures are to the left. Below is an inverted sunspot curve, with scale-figures to the right. The upper points of the latter are minima, and it will be observed how maxima of the thunderstorm curves occur over them or nearly so; and similarly with sunspot maxima and minima of the other curves. There is not always exact coincidence, but a very considerable correspondence will be noticed. (I do not here reproduce the figures yielding those curves.)

It is to be regretted that the official Greenwich records do not, so far as I know, contain any tabulated series of figures relating to thunderstorms in a long course of years. From an examination of the *Greenwich Observations* and the *Weekly Return*, I am enabled to present a table of the number of days on which thunder was observed during the six months April to September in each year from 1850 to 1891. The actual figures are given in one column, and another column gives smoothed values (five year averages). In the curve made from these smooth values, we find maxima corresponding closely with the sunspot minima of 1856 and 1878, and it is now, apparently, near another pronounced maximum which would correspond with the sunspot minimum of 1889 (I may mention that the number of thunder days this year is, thus far, small, and the smoothed curve seems likely to go down). The sunspot minimum of 1867 seems not to be represented in the curve.

Whether or not we may regard this curve as lending support to the view in question, it may at least prove interesting to observe how our summer thunderstorms have varied in number of late years. The Thunderstorm Committee of the Royal Meteorological Society have not yet, I understand, attacked the question of a possible relation to sunspots. May it not be said, however, that the field looks promising?



While some other Continental records of thunderstorms treated in the same way yield results similar to those for Berlin and Geneva, there are some which cannot be said to support the view under consideration (though also not positively against it). When one reflects on the unsatisfactory nature of many thunderstorm records extending over a long series of years, vitiated by such things as a change of observers, or of the mode of observation or of record, &c., this need hardly be thought surprising.

Year.	Greenwich. Days Thunder (Apr.–Sept.).	Smoothed Values.	Year.	Greenwich. Days Thunder (Apr.–Sept.).	Smoothed Values.
1850	8	—	1871	12	10·4
1851	9	—	1872	17	11·8
1852	11	9·6	1873	9	12·2
1853	11	10·2	1874	12	12·0
1854	9	10·4	1875	11	11·0
1855	11	10·6	1876	11	14·4
1856*	10	11·4	1877	12	14·6
1857	12	12·6*	1878*	26	17·2*
1858	15	12·2	1879	13	16·8
1859	15	12·4	1880	24	15·6
1860	9	11·2	1881	9	13·6
1861	11	9·4	1882	6	13·2
1862	6	7·8	1883	16	11·0
1863	6	8·6	1884	11	10·8
1864	7	7·6	1885	13	10·8
1865	13	9·0	1886	8	11·4
1866	6	9·8	1887	6	13·8
1867*	13	9·4	1888	19	13·8
1868	10	8·6	1889*	23	16·2*
1869	5	9·8	1890	13	—
1870	9	10·6	1891	20	—

Minimum sunspots and maximum thunder days (smoothed values) indicated by an asterisk.

A. B. M.

The Nova Aurigæ.

THE Nova Aurigæ was observed on the night of September 14, with the Newall telescope, under favourable circumstances. It was almost exactly equal in brightness with the star 85" nf; which of the two was brighter it was difficult to say, because of a peculiarity noted below, but its magnitude may be taken as close upon 10·3.

The spectrum, as seen with a compound prism between eye and eye-piece, showed a very faint continuous spectrum, varying from C to F (or? G);

a bright line quite, or nearly, coincident with C;
three bright lines close together in the green, the least refrangible one seeming considerably broader than the others;
a faint bright line in the blue (? F);

and with great difficulty I saw at times a still fainter line in the violet. I failed to make out that the bright lines had the dark companions seen in the spring. At first sight the spectrum seemed to consist of a single broad bright line in the green.

With a power of 215 (without spectroscope) I at first thought that the Nova was diffuse, and resembled a minute planetary nebula rather than a star; but on focussing more carefully, I made out that the Nova was distinctly stellar; now, however, the neighbouring stars resembled planetary nebulæ. In fact the Nova and neighbouring stars could not be focussed simultaneously. With a power 500 the effect was of course more marked. The Nova owes its visual magnitude nearly entirely to the light that gives rise to the three green lines in the spectrum, and it is interesting to note that it was possible to verify a conclusion drawn from this fact and from the nature of the chromatic dispersion of a refractor of 29 feet focal length:—the image of the Nova was distinctly more point-like than that of the neighbouring equally bright star, when each in turn was focussed as carefully as possible.

H. F. NEWALL.

Ferndene, Gateshead-on-Tyne.

Atmospheric Depressions and their Analogy with the Movements of Sunspots.

A SOMEWHAT prolonged absence from home has prevented me seeing until now your note on July 21, page 280, in which the writer remarks that the results of M. Camille Flammarion—published in the July number of *L'Astronomie*—"seem to confirm the view suggested by M. Faye that the constitution of [sun] spots resembles somewhat that of the cyclones with which we are familiar."

I write to point out that this is not the theory of M. Faye, but, on the contrary, is the theory of Mr. Herbert Spencer, which he published in the *Reader* for February 25, 1865, and which has since been republished in his collected essays under the title, "The Constitution of the Sun." In it Mr. Spencer first points out the untenability of M. Faye's hypothesis, and then goes on to say:—"The explanation of the solar spots above suggested, which was originally propounded in opposition to that of M. Faye, was eventually adopted by him in place of his own. In the *Comptes Rendus* for 1867, vol. lxiv., p. 404, he refers to the article in the *Reader*, partly reproduced above, and speaks of me as having been replied to in a previous note. Again, in the *Comptes Rendus* for 1872, vol. lxxv., p. 1664, he recognizes the inadequacy of his hypothesis, saying:—'Il est certain que l'objection de M. Spencer, reproduit et développée par M. Kirchoff, est fondée jusqu'à un certain point; l'intérieur des taches, si ce sont des lacunes dans la photosphère, doit être froid relativement . . . . Il est donc impossible qu'elles proviennent d'éruptions ascendantes.' He then proceeds to set forth the hypothesis that the spots are caused by the precipitation of vapour in the interiors of cyclones. But though, as above shown, he refers to the objection made in the foregoing essay to his original hypothesis, and recognizes its cogency, he does not say that the hypothesis which he thereupon substitutes is also to be found in the foregoing essay. Nor does he intimate this in the elaborate paper on the subject read before the French Association for the Advancement of Science, and published in the *Revue Scientifique* for March 24, 1883. The result is that the hypothesis is now currently ascribed to him. I should add that, while M. Faye ascribes solar spots to clouds formed within cyclones, we differ concerning the nature of the cloud. I have argued that it is formed by rarefaction, and consequent refrigeration, of the metallic gases constituting the stratum in which the cyclone exists. He argues that it is formed within the mass of cooled hydrogen drawn from the chromosphere into the vortex of the cyclone. Speaking of the cyclones, he says:—' Dans leur embouchure évasée ils entraîneront l'hydrogène froid de la chromosphère, produisant partout sur leur trajet vertical un abaissement notable de température et une obscurité relative, due à l'opacité de l'hydrogène froid englouti' (*Revue Scientifique*, March 24, 1883). Considering the intense cold required to reduce hydrogen to the 'critical point,' it is a strong supposition that the motion given to it by fluid friction on entering the vortex of the cyclone, can produce a rotation, rarefaction, and cooling, great enough to produce precipitation in a region so intensely heated." —(*Essays*, 1891 Edition, vol. i., pp. 188-9.)

Churchfield, Edgbaston. F. HOWARD COLLINS.

Direct Determination of the Gravitative Constant by Means of a Tuning-fork. A Lecture-Experiment.

THE following direct experiment for finding the value of the constant g has proved an instructive one for use with students beginning dynamics, and combines extreme simplicity with greater accuracy than might be anticipated.

A rectangular strip of thick plate-glass with one face lightly smoked is dropped past the end of a sounding tuning-fork of known pitch, and which, by means of a light attached style, traces on the smoked surface a fine rippling line whose undulations give a complete record of the relative motion. From measurements of such a trace the value of g can be determined immediately with an error of not more than $\frac{1}{2}$ per cent.

For let l_1 and l_2 be the distances fallen through in two equal consecutive intervals of time (t). Then $\frac{l_1}{t}$ and $\frac{l_2}{t}$ are the velocities at the middles of these two intervals, and $\frac{l_2 - l_1}{t}$ is therefore the velocity gained in time t, and $\frac{l_2 - l_1}{t^2}$ is the acceleration.

With a fork giving 384 complete oscillations per second it was found convenient to take for t the time of 30 oscillations; l_1 is then the length of any 30 consecutive waves and l_2 that of the next 30. These lengths were measured by means of a millimetre scale printed on card and held against the trace, tenths of a millimetre being estimated. The value of the difference $(l_2 - l_1)$ was thus determined from several measures made in different parts of the trace, and, after some preliminary trials, it was found that such measures seldom differed by more than $\frac{1}{2}$ per cent. from their mean, and that the means of different traces agreed about equally well among themselves. Under the given conditions $(l_2 - l_1)$ is just under 6 centimetres. The experiment takes only a moment to perform, and the plate can be at once exhibited as a lantern slide.

In order to obtain good traces a little care must be exercised. The smoking should be very light. A fine bristle from a clothes- or hearth-brush, 2 to 4 cm. long, stuck on with a scrap of wax, may be used as a style, and it should be inclined downwards so as to make an angle of 45° or less with the vertical face of the plate and project well under the plate before this is let fall, so as to be considerably bent while tracing. By furnishing each prong with such a bristle two simultaneous tracings are obtained. Although the method is independent of the actual velocity with which the plate reaches the style, yet it is best to let the plate fall from quite close above the end of the style (within, say, 1 cm.), so that as many wave-lengths as possible may be marked on the plate. The fork also should be strongly bowed with a violin bow, so as to give sharply accentuated ripples, the positions of whose crests are defined with greater precision than would be those of gentler undulations. The plate itself can be conveniently let go if the upper part of its suspension is a single string with a knot at the top, and to prevent its swinging in the air or turning as it descends, it may be held against a narrow smooth backing of hard wood. Without these precautions the trace is liable to show curvature and other irregularities, and indeed under any circumstances the first one or two undulations traced near the advancing edge of the plate are liable to be irregular. The more massive the plate the less is its motion affected by the pressure of the tracing style.

Although as a means of finding the value of g such a method does not compare for accuracy with the use of a pendulum, yet for the converse process of determining the pitch of a fork from measures of its trace and the known value of g, it may be of utility; for, since the length $(l_2 - l_1)$ is proportional to the *square* of the vibration-number, the percentage error will now be halved or reduced to about 1 in 400, and I have little doubt that a careful experimenter, by attending to the causes of error, might further improve on this. A. M. WORTHINGTON.

R.N.E. College, Devonport, September 12.

A Meteor.

ON Wednesday, September 14, at 7h. 9m. p.m. a large meteor was seen by about twenty people, including myself, who were driving from Penmaenmawr to Conway. It was first observed in the south-east just above the Conway mountain. It was visible for about 30°, fell very slowly in a wavy line inclined at a small angle to the horizon, disappearing behind the mountain. It seemed to be very near the ground as it passed over the mountain.

The sky was quite bright, so that only Mars was clearly visible in it. The meteor appeared to the eye about the size and brightness of Jupiter at the present time, and was of a slightly bluer tint than that planet. There was no perceptible variation in size and brilliance while the meteor was in sight.

September 19. GRACE E. CHISHOLM.

Crater-like Depression in Glaciers.

A PROPOS de la cavité du glacier de Tête Rousse que M. Vallot et moi avons découverte et dont vous parlez dans NATURE (September 1), M. R. von Lendenfeld vous écrit (NATURE, September 15) qu'il a trouvé des dépressions cratériformes sur le glacier de Tasman, dans la Nouvelle Zélande. Permettez-moi de vous signaler que de pareilles dépressions existent sur certains glaciers des Alpes et notamment sur le glacier de Gorner, où la carte suisse en indique 26. Elles sont en général à peu près circulaires; leur plus grande dimension horizontale atteint parfois 130 mètres et leur profondeur 30 mètres. L'inclinaison de leurs parois varie en général de 45° à la verticale. Elles reçoivent souvent de l'eau qui s'engouffre au fond dans un moulin ou qui s'écoule, par une crevasse, dans une dépression voisine. Au mois d'août dernier, l'une d'elles formait un véritable petit lac glaciaire que j'ai sondé avec M. Etienne Ritter au moyen d'un bateau démontable; la profondeur de l'eau était presque partout de 5 à 6 mètres, sauf dans un trou, vraisemblablement un moulin, où ma sonde est descendue jusqu'à 21 mètres. Il est probable que, lorsque la pression de l'eau aura élargi le moulin par où elle s'écoule, la cavité se videra.

Les dépressions ne me paraissent avoir aucune analogie avec la cavité que j'ai vue à Tête Rousse. Leur origine est assez mal connue (voir Heim, "Gletscherkunde," p. 246); il est possible, comme le pensait primitivement votre honorable correspondant, qu'elles soient d'anciens moulins transformés.

J'en ai vu une également sur la Mer de Glace, entre le Montanvers et le Tacul.

L'étude de ces dépressions, encore très incomplète, serait très intéressante, et je les signale à l'attention de ceux qui parcourent les glaciers.

Veuillez agréer, monsieur, mes civilités empressées.

Thonon, le 17 Septembre. ANDRÉ DELEBECQUE.

GENERALIZATION OF "MERCATOR'S" PROJECTION PERFORMED BY AID OF ELECTRICAL INSTRUMENTS.

THE following mode of generalizing Mercator's Projection is merely an illustration of a communication to Section A of the British Association at its recent meeting in Edinburgh, entitled "Reduction of every Problem of Two Freedoms in Conservative Dynamics to the Drawing of Geodetic Lines on a Surface of given Specific Curvature." An abstract of this paper appeared in NATURE for August 18.

In 1568, Gerhard Krämer, commonly known as "Mercator" (the Latin of his surname), gave to the world his chart, now of universal use in navigation. In it every island, every bay, every cape, every coast-line, if not extending over more than two or three degrees of longitude, or farther north and south than a distance equal to two or three degrees of longitude, is shown very approximately in its true shape: rigorously so if it extends over distances equal only to an infinitesimal difference of longitude. The angle between any two intersecting lines on the surface of the globe is reproduced rigorously without change in the corresponding angle on the chart.

Mercator's chart may be imagined as being made by coating the whole surface of a globe with a thin inextensible sheet of matter—sheet india-rubber for example (for simplicity, however, imagined to be perfectly extensible but inelastic)—cutting away two polar circles to be omitted from the chart; cutting the sheet through along a meridian, that of 180° longitude from Greenwich for example, stretching the sheet everywhere except along the equator so as to make all the circles of latitude equal in length to the circumference of the equator, and stretching the sheet in the direction of the meridian in the same ratio as the ratio in which the circles of latitude are stretched, while keeping at right angles the intersections between the meridians and the parallels. The sheet thus altered may be laid out flat or rolled up, as a paper chart.

What I call a generalized Mercator's chart for a body of any shape spherical or non-spherical, is a flat sheet showing for any intersecting lines that can be drawn on a part of the surface of the body, corresponding lines which intersect at the same angles. One Mercator chart of finite dimensions can only represent a part of the complete surface of a finite body, if the body be simply continuous; that is to say, if it has no hole or tunnel through it. The whole surface of an anchor ring can obviously be mercatorized on one chart. It is easily seen, for the case of the globe, that two charts suffice to mercatorize the whole surface; and it will be proved presently that three charts suffice for any simply continuous closed surface, however extremely it may deviate from the spherical form.

In "Liouville's Journal" for 1847, its editor, Liouville, gave an analytical investigation, according to which, if the equation of any surface whatever is given, a set of lines drawn on it can be found to fulfil the condition that the surface can be divided into infinitesimal squares by these lines and the set of lines on the surface which cut them at right angles. Now it is clear that if we have any portion of a curved surface thus divided into infinitesimal square allotments, that is to say, divided into infinitesimal squares, with the corners of four squares together, all through it, we can alter all these squares to one size and lay them down on a flat surface with each in contact with its four original neighbours; and thus the supposed portion of surface is mercatorized. Except for the case of a figure of revolution, or an ellipsoid, or virtually equivalent cases, Liouville's differential equations are of a very intractable kind. I have only recently noticed that we can solve the problem graphically (with any accuracy desired if the problem were a practical problem, which it is not) by aid of a voltmeter and a voltaic battery, or other means of producing electric currents, as follows:—

1. Construct the surface to be mercatorized in thin sheet metal of uniform thickness throughout. By thin I mean that the thickness is to be a small fraction of the smallest radius of curvature of any part of the surface.

2. Choose any two points of the surface, N, S, and apply the electrodes of a battery to it at these points.

3. By aid of movable electrodes of the voltmeter, trace an equipotential line, E, as close as may be around one electrode, and another equipotential line, F, as near as may be around the other electrode. Between these two equipotentials, E, F, trace a large number, n, of equidifferent equipotentials. Divide any one of the equipotentials into n equal parts; and through the divisional points draw lines cutting the whole series of equipotentials at right angles. These transverse lines and the equipotentials divide the whole surface between E and F into infinitesimal squares (Maxwell, "Electricity and Magnetism," § 651).

4. Alter all the squares to one size and place them together, as explained above. Thus we have a Mercator chart of the whole surface between E and F.

N and S of our generalization correspond to the north and south poles of Mercator's chart of the world; and our generalized rule shows that a chart fulfilling the essential principle of similarity realized by Mercator may be constructed for a spherical surface by choosing for N, S any two points not necessarily the poles at the extremities of a diameter. If the points N, S are infinitely near one another, the resulting Mercator chart for the case of a spherical surface, is the stereographic projection of the surface on the tangent plane at the opposite end of the diameter through the point, C, midway between N and S. In this case the equipotentials and the stream-lines are circles on the spherical surface cutting N S at right angles, and touching it, respectively.

For a spherical or any other surface we may mercatorize any rectangular portion of it, A B C D, bounded by four curves, AB, BC, CD, DA, cutting one another at right angles as follows. Cut this part out of the complete metallic sheet; to two of its opposite edges, A B, D C, for instance, fix infinitely conductive borders. Apply the electrodes of a voltaic battery to these borders, and trace n equidifferent equipotential lines between AB and DC. Divide any one of these equipotentials into n equal parts, and through the divisional points draw curves cutting perpendicularly the whole series of equipotentials. These curves and the equipotentials divide the whole area into infinitesimal squares. Equalize the squares and lay them together on the flat as above.

If we have no mathematical instruments by which we can draw a system of curves at right angles to a system already drawn, we may dispense with mathematical instruments altogether, and complete the problem of dividing into squares by electrical instruments as follows: Remove the conducting borders from AB, DC; apply infinitely conductive borders to AD and BC, apply electrodes to these conducting borders, and as before draw n equidifferent equipotentials. This second set of equipotentials, and the first set, divide the whole area into squares.

KELVIN.

THE ACTIVE ALBUMEN IN PLANTS.[1]

ONE of the most important chemical functions of plant-cells is that synthesis of albuminous matter which serves for the formation of protoplasm. The *living* protoplasm, however, is composed of proteids entirely different from the ordinary soluble proteids, as well as from the proteids of *dead* protoplasm. In other words, if living protoplasm dies, the albuminous constituents change their chemical character. We observe that in the living state a faculty of autoxidation (respiration) exists, which is wanting in the dead condition; and Pflüger, in 1875, drew from this the conclusion that in protoplasm the chemical constitution of the living proteids changes at the moment of death.

Various other considerations force us to accept this logical conclusion. Chemical changes readily occur in all those organic compounds that are of a *labile* character. There exist so-called labile atom-constellations that are in lively motion, and are thus prone to undergo change, the atoms falling into new arrangements which

[1] This paper was read before the Liège meeting of the International Congress of Physiologists, of whose proceedings we gave some account last week.

present more stable constellations.[1] We do not doubt that *vital force is a mode of motion* due to the presence of atoms in labile positions in the albuminous substance. The motion ceases when there occurs a migration of the labile atoms to some stable position. The aldehydes give us fine illustrations of labile combinations and stable rearrangements in other allied substances.

The question now arises, can we chemically demonstrate that the albuminous substance formed by synthesis in plants is—*even before it has become protoplasm*—different from ordinary albumen? It was known long ago that the juice of plants—that is the aqueous solution in the vacuoles of the cells—contains albumen, but it was thought to be ordinary albumen. It is easy to prove that this is not the case.[2]

On treating living plant cells with dilute solutions of ammonia or organic bases or their salts, remarkable changes are observed. These consist either in the formation of numerous minute granules as is the case on the application of most of the bases, or in the production of little globules flowing together to make relatively large drops of a substance of high refractory power, as is the case on the application of weak bases like caffein or antipyrin.[3] These latter two bases in weak solution do not injuriously affect the protoplasm itself, since the cells will keep alive for a number of days in a 0·5 per cent. solution of these bases; the cells are, however, soon killed by other bases and their salts. The granules and globules formed in the living cells by the action of caffein have been called by Bokorny and myself *Proteosomes*. They give the principal reactions of albuminous bodies, but contain in most cases an admixture of small quantities of lecithin and tannin. These admixtures, however, can be removed by cultivating the objects (the alga, Spirogyra, for instance) in solutions rich in nitrates. If now by such cultivation the tannin has been removed and the proteosomes then produced by treatment with caffein, we can observe that these albuminous proteosomes are capable of reducing silver from even highly diluted alkaline solutions. This property is lost after treatment with dilute acids as well as after the death of the cells.[4] In these cases the proteosomes become hollow and turbid, their substance appearing to coagulate and shrink.

There are thus experimental grounds for the conclusion that not only the organized albumen of the living protoplasm, but also the albumen dissolved in the vacuoles—the unorganized albumen—is a different substance from the ordinary albumen, which is present in dead cells. We may sum up the line of argument as follows:—

I. Bases act upon the albumen of living cells; not, however, upon that of dead cells, nor upon ordinary dissolved albumen.

II. The action may be observed microscopically to take place in the case of various vegetable objects in the liquid portion of the protoplasm itself as well as in the vacuoles. This can be specially well observed with the alga Spirogyra when treated with caffein.

III. The granules and globules into which the active albumen aggregates by the action of bases—called by us proteosomes—have the property of reducing dilute silver solutions in the absence of light, and lose this property by the action of acids.

IV. The active albumen in its most *unchanged* condition can be made visible by caffein or antipyrin, two bases that do not act as serious poisons to the cells. Living cells containing proteosomes, brought out by caffein when placed in distilled water regain their original condition, the proteosomes become gradually dissolved again (rapidly at 25°C.), and a new application of caffein will now make them reappear.

V. If proteosomes are produced by caffein or antipyrin, and the death of the cells is then caused by ether vapour, &c., it may be easily observed that soon after the death of the protoplasm the proteosomes of the vacuoles are also changed in their optical and chemical properties; they become turbid and hollow, they coagulate, and they lose their property of being resoluble in distilled water.

O. LOEW.

[1] Many examples can be cited from organic chemistry; for instance, the rapid change of the diamidoaceton as soon as it is liberated from its salts (Berichte d. Deutschen Chem. Ges. 25, 1563). Compare also the article, "Chemical Motions," Biolog. Centralblatt ix. N. 16.

[2] O. Loew und Th. Bokorny, Biolog. Centralblatt xi. 1.

[3] These globules closely resemble the aggregated masses that Darwin observed after irritation of leaves of Drosera.

[4] The proteosomes produced by ammonia and various other bases preserve this property for a much longer time after the death of the cell than those produced by caffein or antipyrin.

DISCOVERY OF A FIFTH SATELLITE TO JUPITER.

IN January of the year 1610 Galileo, at Padua, in Italy, discovered four satellites revolving round Jupiter, and though more than 282 years elapsed in the interval, from that time to August, 1892, no additional satellites were detected near this planet, and astronomers naturally inferred that no others existed. The fact that Jupiter possessed four satellites has become familiar to every schoolboy, for it has been repeated in all the astronomical text-books published during nearly three centuries. Few people therefore could have imagined that the statement would ever be controverted or rendered untenable by new discoveries. In regard to the more distant planets Uranus and Neptune, there was every prospect of additional satellites being detected, but with Jupiter the circumstances were somewhat different. The four satellites were so bright and so palpably visible in very small telescopes that it was scarcely thought possible that another existed small enough to remain unseen. Moreover, there was a significant agreement in the relatively increasing numbers of the satellites surrounding the planets Mars, Jupiter, and Saturn. Mars was known to have two satellites, Jupiter four, and Saturn eight, the number doubling itself with each step outward from the sun, and it was considered probable that the harmony of the series would not be disturbed.

Now, however, the astronomical world has been excited by the announcement that a new satellite has been discovered in attendance on Jupiter, and that its distance from the centre of the planet is 112,400 miles, and its period of revolution 17 hours 36 minutes. The discovery was effected by Prof. Barnard, of the Lick Observatory on Mount Hamilton in California, and, as he has already proved himself a very acute observer, especially of comets, and as he has the occasional use of what is supposed to be the most powerful telescope hitherto constructed, there is no good reason to discredit the intelligence.

People will be obviously led to ask how this new satellite managed to evade detection during nearly three centuries of diligent telescopic research. How was it that one at least of the host of observers who have studied this plane and his circling moons by means of powerful glasses, did not sight the tiny orb which has now revealed itself to the watchful American astronomer? We imagine that the chief reason for this want of success is to be found in the fact that the new orb is not brighter than the thirteenth magnitude, and that, being situated close to its primary, it would therefore, in ordinary instruments, be quite obliterated in the surrounding glare. But it is perhaps rather singular that it was not detected by its shadow, which would be projected on the disc of Jupiter whenever the satellite passed between the planet and the earth, and this would be of daily occurrence. At such a time the shadow would appear as a small, black, circular spot moving rapidly from east to west across the disc, and with greater apparent velocity than the visible markings. And it is quite possible that the shadow has been observed on more than one occasion, but mistaken for an ordinary spot on the surface of Jupiter.

A curious fact in connection with the new satellite is its diminutive size as compared with the four others discovered by Galileo in 1610. But there is a similar disparity in the dimensions of the satellites of Saturn, and in proof of this we have only to compare the bright *Titan* with the excessively faint *Mimas* and *Hyperion*. Small as it is, however, it is certain that this new satellite of Jupiter is much larger than either of the two abnormally minute moons of Mars.

American astronomers are to be congratulated on this important discovery. Scientific activity in the United States has been rapidly developing in recent years, and this has been strikingly exemplified in the wide and attractive domain of astronomy. W. F. DENNING.

NOTES.

THE French Association for the Advancement of Science is holding at Pau its twenty-first annual meeting. The meeting began on Saturday last, when the members of the Association were cordially welcomed to Pau by the Mayor. The President, M. Collignon, delivered an address on the science and art of the engineer.

THE autumn meetings of the Iron and Steel Institute, under the presidency of Sir Frederick Abel, began at St. George's Hall, Liverpool, on Tuesday. At the opening meeting the President announced that the Council had elected Mr. Windsor Richards as his successor.

WE are glad to announce that a new Biological Laboratory is about to be established in the Calcutta Zoological Gardens. Babu Joy Gobinda Law, a member of one of the wealthy native families of Bengal, has offered R. 15,000 for the buildings and fittings of this institution. The primary object for which the Laboratory is founded is to investigate the action of snake-poison, and to discover, if possible, an antidote. The Laboratory will, however, also be used for anatomical and pathological researches, for which the rich material afforded by the animals in the gardens will be available.

THE Marine Biological Laboratory at Wood Hole, U.S., has been more successful this summer than in any previous year. During its season of work it had a corps of seventeen officers, instructors, and assistants, and an attendance of thirty-eight investigators and sixty-two elementary students.

WITH the designation of the Hopkins Seaside Laboratory, a marine biological laboratory has been established at Pacific Grove, California. We learn from the *Botanical Gazette* that, through the generosity of the Pacific Improvement Company, a piece of land has been furnished, and a sum granted sufficient to erect a plain frame building; and, by the liberality of Mr. Timothy Hopkins, provision is made for the equipment of the building, and for the further continuation and extension of the enterprise. An elementary course of lectures on marine botany was to be given during the present season.

THE weather during the past week was very fine and bright over the southern and eastern portions of the United Kingdom, until near the close of the period, when the type entirely changed, and thunderstorms, accompanied by heavy rain, occurred generally, but in the north and west the conditions were throughout far less settled. Cyclonic disturbances arrived on our coasts from the Atlantic with considerable frequency, and although they were for the most part slight and shallow, and unaccompanied by much wind, they were productive of a considerable quantity of rain. An important disturbance passed to the north of Scotland on Thursday night and during Friday, and was accompanied by strong gales on our north-west and north coasts. Temperatures were high for the season over the greater part of England, and on Monday the day readings in places were higher than at any time during the month, the shade thermometer registering 72° in London. Some nights, however, were exceptionally cold, the shade minimum between Saturday and Sunday falling to within one degree of the freezing point in the eastern part of England, while there was a sharp frost on the ground open to the sky. The *Weekly Weather Report*, issued on the 17th inst., shows that the rainfall exceeded the mean in the north and west of Scotland and in the north of Ireland. In all the other parts of the United Kingdom there was a deficit; in most of the English districts the fall was very slight.

THE Report of the Meteorological Commission for the year 1891 states that complete, or nearly complete, meteorological observations have been received from forty-nine stations, and that observations of rainfall have been furnished from 320 stations; the instruments are usually supplied by the Commission. The Report contains diagrams showing the mean monthly rainfall corrected to date at thirty-three stations, together with the abnormal falls in the years 1888 and 1891. The rainfall in 1891 has been excessive, especially over the eastern part of the colony and over the Orange Free State, where at some places it exceeded 12 inches above the average. The observer at Phillipolis states that hardly a farmer in that district but has lost one-third of his sheep, owing to the continued wet, and in some places the farmers have had to vacate their homes in consequence of the weather.

THE "Pilot Chart of the North Atlantic Ocean" for September contains tracks of the drift of the two parts of the derelict ship *Fred. B. Taylor*, which was cut in two by a collision on June 22, in lat. 40° 19′ N., long. 68° 33′ W. The forward and after parts separated, and drifted in entirely different directions, in a manner which is quite unprecedented in the history of shipwrecks. The after end was evidently influenced more by wind than the bow portion; the latter pursued a south-westerly course, which was attributable largely to the cold southerly current between the American coast and the Gulf Stream, and on August 26 had drifted to lat. 38° 40′, long. 73° 15′. The stern part took a direct northerly course until July 17, when it was ten miles north-west of Matinicus Island, whence it took a westerly course, and was cast ashore on August 7 on Wells Beach, near Cape Porpoise.

THE first annual convention of the American Association of State Weather Services was held at Rochester, N.Y., on August 15 and 16, in conjunction with the meeting of the American Association for the Advancement of Science, and was largely attended by representatives of the various States. The subject of thermometer exposure was discussed, and a committee was appointed to consider the most suitable form of shelter and manner of exposure to be adopted throughout the country. It was resolved that means should be deduced from self-registering instruments wherever practicable, in preference to the method of using eye observations. An interesting paper was read by W. L. Moore, of Wisconsin, on the forecasting of thunderstorms; and the question of the best methods of signalling weather forecasts, whether by flags, semaphores, spherical bodies hoisted on a staff, &c., was freely discussed, and a committee was appointed to report upon the subject at an early date. It was decided that each State service should have a separate exhibit at the World's Fair at Chicago, and not to have the exhibits collected in the building for the use of the United States Weather Bureau.

LAST year an Aino in the western part of the island of Yezo caught two bears, one of which was perfectly white. This capture created much excitement among the natives, as their chief god is a white bear, and he is supposed to dwell on an inaccessible mountain in the interior of the island, and never to let himself be seen by human beings. The Ainos, therefore, concluded that the young white bear was a sort of Messiah, and after long consideration they decided that he ought to be sent as a present to the Mikado. In due time he arrived at Tokio, and by the Mikado's orders he was received into the Zoological Garden. Heie the animal soon became ill, and Herr J. L. Janson was requested to do what he could for it. Fortunately his treatment of it was successful. At first he thought the creature must be a polar bear; but he soon convinced himself that this was a mistake, and that it was in reality an albino. In the latest number of the "Mittheilungen der Deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens in Tokio," Herr Janson gives a full account of the bear, and he adds some interesting facts as to the importance attributed to white animals generally, and especially to albinos, in Japan. The appearance of an albino is supposed to be a good omen for the reigning monarch. The reign of a sovereign may even be known by the name of a white animal. Thus the reign of one ancient Mikado is called "Hakuchi nenkan," the period of the white pheasant. That of another is "Haku hōō nenkan," the period of the white phœnix. The white fox is often mentioned in fables and temple-stories, and a white serpent always appears in pictures and plastic representations with Benten, the goddess of fortune. As in former times among the Greeks, Romans, Persians, and Scythians, so among the Japanese, horses dedicated to the gods were generally white; and white horses are still found in connection with all the larger temples, and take part in the great annual processions. The milk and butter derived from white cows were formerly held in high esteem as medicine.

MR. F. W. WARD, formerly editor of the *Sydney Daily Telegraph*, has sent to the Agricultural Department of New South Wales a report on recent shipments of fruit from Cape Colony to London. The report is printed in the July number of the *Agricultural Gazette of New South Wales*, which recommends it as "worthy of careful perusal." The *Gazette* refers to the fact that good fruit-growing districts abound in Australia, and that no better fruit can be grown in South Africa than is now being produced in many districts of New South Wales. The chief mistake hitherto, it says, has been the growing of unsuitable varieties—unsuitable not alone for export, but even for ordinary home use. It adds that this defect is being rapidly remedied, and that many growers, who have gained experience by their own efforts, are settling down to the work with intelligent earnestness.

WRITING of wild strawberries in Ceylon, Mr. Nock says in the *Ceylon Observer* that the species *Fragaria vesca*, which grows so luxuriantly and fruits so abundantly in Jamaica, is now growing wild in many places in the Nuwara Eliya district. If the soil in Ceylon were as good as it is in the Blue Mountains of Jamaica, and there was less Nilu (*Strobilanthes*), this strawberry would soon, he thinks, be as plentiful in the hill districts of Ceylon as it is there. When Mr. Nock was Superintendent of the Government Cinchona Plantation in Jamaica, he has given as many as twenty free tickets in one day to old women and children to gather strawberries among the Cinchona Plantations. He has known them gathered by the bushel, and carried twenty-two miles to the Kingston market, where they always commanded a good price. He adds that he has this year raised seedlings of six of the best English varieties, to which he intends to give a fair trial in the Nuwara Eliya district.

THE University of Minnesota has begun the publication of a *Quarterly Bulletin*, under the management of a board of editors. The chief editor being Prof. Conway M'Millan, the professor of botany to the University, is a guarantee that the interests of science will not be neglected in the *Bulletin*; and the first number contains several items of information of interest to American botanists.

IN the report of the Royal Botanic Garden, Calcutta, for the year 1891–92, it is shown that the year was one of great activity as regards outdoor operations. The abnormally dry season proved very trying to many exotics, and, though for a time all other work was suspended and the whole garden staff was employed only in watering plants, many casualties occurred, especially among the finer and rarer plants. The attention of the staff was as usual largely directed to the cultivation and distribution of plants of economic interest. The chief event of the year under this head was the introduction of the aloe, which yields "sisal hemp" (*Agave rigida*, var. *sisalana*). The Director of the Royal Gardens, Kew, in June 1891, kindly obtained a consignment of plants for the Calcutta Garden from Florida, and kept these at Kew till they were strong enough to stand the voyage to Calcutta. The boxes reached Calcutta on October 29, 1891; unfortunately a considerable percentage of the plants died on the way out, and it was necessary to nurse the survivors carefully before they could be distributed. Over 19,000 specimens were contributed to the Herbarium during the year from various sources; while the distribution of authentically-named specimens to other herbaria reached the high total of 10,505 sheets. The chief benefactor to the Calcutta Herbarium was again the Royal Herbarium, Kew, to the Director of which institution the Calcutta one "owes a debt that can never be repaid." Among other contributors was Baron von Mueller, who again sent a beautiful collection of Australian plants. The Herbarium was also greatly enriched by further accessions of Tibetan, Chinese, and Mexican specimens, and the Saharanpur Herbarium presented 954 plants from the north-west Himalaya. Dr. Prain visited the Andaman Islands, Mount Parashak, and the Khasia, and was thus enabled to add valuable collections. Much good work was also done by collectors employed by the Calcutta Garden.

IN the second number of the *Journal of the Polynesian Society* Dr. A. Carroll, of Sydney, offers what he believes to be translations of some of the famous Easter Island inscriptions. He is of opinion that Easter Island was at one time occupied by a pre-Polynesian people from America, and that to them the inscriptions are to be attributed. "While engaged in studying the languages, histories, antiquities, and inscriptions of ancient American peoples," he says, "I came upon similarities to the Easter Island characters, &c.; with these as keys, discovered what certain groups expressed, and from these, proceeding upon the recognized methods of decipherment, succeeded in reading into the original languages, and from these translating into English these Easter Island inscriptions." This is very vague, and, until Dr. Carroll gives some more definite information as to his methods, his claim that "another ancient writing is deciphered" will seem somewhat extravagant. Among the other contents of the number are an interesting account of some stone implements from the Chatham Islands, by Mr. S. Percy Smith, and the first part of a history of the occupation of the Chatham Islands by the Maoris in 1835, by Mr. A. Shand. Mr. Shand's information has been derived from the Maoris themselves, many of those who supplied it having taken part in the transactions they described.

MR. WILLIAM KENT, writing in *Science* on the American Association for the Advancement of Science, complains that it does not adequately represent the scientific movement in the United States. He points out that while more than 2000 members attended the Edinburgh meeting of the British Association, there were not 500 members at the Rochester meeting of the American Association, and of this number New York State contributed far more than its quota. In proportion to its population, Ohio sent twice as many members as Pennsylvania, although its average distance from Rochester is greater. Moreover, the several branches of science are not equally represented. Mechanical and engineering science, which is developing in the country by leaps and bounds, sends to the Association only one-fourth as many members as chemistry, and one-eighth as many as biology. The physical sciences, Mr. Kent says, are "dwarfed by the natural sciences." This he attributes to the fact that those who devote themselves to applied science have so many societies of their own that they are diverted from and lose their interest in the American Association. In engineering there are four large national societies, the civil, the mechanical, the mining, and the electrical, besides numerous local societies, aggregating a membership of probably 5000 persons, not counting duplications of those who belong to two or more societies.

A MOVEMENT has been started in Melbourne for the passing of a law which may tend to prevent the wanton destruction of birds in Victoria. A deputation, organized by the Victoria Field Naturalists' Club and representing the Melbourne Royal Society, Royal Agricultural Society, Royal Horticultural Society, and Zoological and Acclimatization Society lately brought the subject under the notice of the Ministers of Customs. In introducing the deputation, Messrs. G. D. Carter and J. Bosisto dwelt upon the necessity of protecting insectivorous birds from the reckless and indiscriminate shooting which is now so prevalent, as well as human lives, which are frequently sacrificed to the inexperience of sportsmen. The imposition of a gun tax as a legitimate source of revenue was also suggested. Prof. Kernot (Royal Society), Mr. C. M. Officer (Zoological Society), and Mr. C. Draper (Royal Agricultural Society) also emphasized these views. Mr. F. Wisewould referred to the draft which had been drawn up by the sub-committee of the Field Naturalists' Club—a draft based upon similar Acts in England and some of the Australian colonies. A few new features had, however, been added, notably that which made it illegal for persons under the influence of liquor to carry firearms. It was also provided that under no circumstances should a licence be given for the use of swivel guns. In answer to the deputation the Minister said that he would take the draft bill which had been prepared into favourable consideration. He would have an amended draft drawn up and submitted to those interested before its introduction into Parliament. He was of opinion that a 5*s*. tax, as proposed, was not heavy enough, since it would be worth the while of those who let out guns to pay the tax themselves.

THE serum of blood used to be regarded as merely a nutritive liquid; but it has been found to play a more important part, being capable of killing disease-germs, and of destroying and dissolving the red blood corpuscles of other animals. These properties have been recently studied by Herr Buchner (*Münchener Med. Wochenschrift*). They are gradually lost when the liquid has been removed from the animal. They are also destroyed by heating half-an-hour to 52° to 55° C. (A dog's serum stops the amœba-like movements of white-corpuscles of another animal species without killing them: but this property is also lost by heating to 55°.) Light also stops both actions; and diffuse daylight more than direct sunlight. It is apparently albumens in the serum that are operative; but whether all the albuminoid constituents, or certain specific albumens, was not determined. It is remarkable that solution of the serum with a 0·7 per cent. solution of common salt does not spoil the action, whereas a similar dilution with pure water makes the serum nearly inactive. But serum thus made inactive with water recovers its properties if salt solution is added; and this is the case even when the serum has been kept in the active state for four to 24 hours in ice. Serum may also receive a 0·7 per cent. solution of potassium or lithium chloride, or various other salts of the fixed alkalis, without losing its germicide properties. Ammonium salts even stimulate the latter. Herr Buchner calls the albumens in question alexines (or protective matters); he supposes they have a like action on foreign cells generally. The serum of dogs and rabbits having been mixed, the power of both alexines was weakened, but those of the rabbit more than those of the dog (to typhus bacilli). After acting some time on each other the globulicide power was quite extinguished. The author finds in these facts an explanation of the antitoxical action of the serum of animals protected against disease.

ACCORDING to the *Revista Financiera Mexicana*, quoted in the current number of the *Board of Trade Journal*, a deposit of onyx of considerable importance has just been discovered in Mexico, about 50 kilometres south of El Paso. It is said to be of superior quality, with fine grain, and richly shaded with delicate and varied tints. Blocks of considerable dimensions can be easily extracted.

DR. MORRIS GIBBS writes to *Science* from Kalamazoo, Michigan, that in that State there are to his knowledge six species of birds which feed on acorns. Of these, the passenger-pigeon and mourning-dove swallow the acorn entire, with its shell intact, only removing the cup or rough outside covering. The white-bellied nut-hatch occasionally hoards the acorns away, and only draws on its store after some months, and when the firm shelly covering readily gives way to its sharp, prying bill. The other three are the well-known blue-jay, common crow-blackbird, and red-headed woodpecker. So far as he has been able to learn, these birds, except in rare instances, do not pick the acorns from the tree, but have to content themselves with the fallen fruit. The red-head, deigning to descend to the ground, seizes an acorn, and flying with it in its bill to a spot where there is a small cavity in the dead portion of a trunk, or to a crevice in the bark, immediately begins to hammer it with its sharp-pointed bill. In a couple of strokes, it has removed the outer shell or cup, and at once attacks the still green-coloured shell which directly surrounds the meat. The inside, or shell proper, quickly gives way, usually nearly in halves, and the woodpecker enjoys the kernel. The woodpeckers are as nearly strict insect-feeders as any birds in Michigan, unless an exception is made of the swifts and swallows, yet here is an instance of a varied diet. However, the red-head is quickly satisfied in the acorn line, and soon begins circling the trunk, or more often limbs, for his legitimate food. The blackbird confines himself to the ground in his efforts for acorn meats. Walking up sedately to an acorn, and making no effort to seize or confine it, it strikes savagely and almost aimlessly. Its bill frequently glances, and the splintered shell dances about, until at last a huge piece of the kernel is dragged out, after which the bird leaves for other quarters or begins on another acorn. The jay swoops down with flaunting blue wings, and, seizing the largest acorn on the ground, flies to the nearest convenient limb or to the decayed ridge-board of an adjacent building. There, firmly pressing the nut between his big, black feet, he hammers away with a vengeance, and quickly tears off nearly half of the shell, after which he proceeds to pick out the meat in small bits. The cup is often left nearly perfect, the jay never making an effort to secure the nut entire, which he could easily do. Walking under the oaks, one can readily tell whether the woodpeckers, blackbirds, or jays have been at work among the acorns, by the appearance of the mutilated shell-remains lying about.

THE following arrangements have been made for science lectures at the Royal Victoria Hall during October:—October 4, Sir John Lubbock on "Books." After the address he will present the prizes and certificates gained by students of the M. M. College, Prof. Foxwell in the chair. October 11, Mr. C. T. Dent (late President of the Alpine Club), on "The Alps in Winter." October 18, Mr. F. W. Rudler, on "Frost and Fire," with special reference to the flood at St. Gervais, and the eruption of Etna. October 25, Col. Swinhoe on "Some Curiosities in Nature."

LAST week we noted that Messrs. Macmillan and Co. had issued a new edition of "Arithmetic for Schools." This is the well-known work by Mr. Barnard Smith. The book has been revised and enlarged by Prof. W. H. H. Hudson.

MESSRS. GAUTHIER-VILLARS have issued "Bulles de Savon," a translation, by C. E. Guillaume, of Mr. Boys' little work on "Soap Bubbles." The translator, while reproducing the main features of the book, has, with the author's sanction, adapted it for the use of French readers. He has also incorporated an account of some new experiments which Mr. Boys has brought to his notice.

THE first number of a new German journal, which promises to be of considerable interest to non-professional students of science, has just been issued in Berlin, the publisher being R. Oppenheim. It is entitled *Natur und Haus*, and is edited by L. Staby and M. Hesdorffer. The articles are written in a popular style, and well illustrated.

THE additions to the Zoological Society's Gardens during the past week include a Mona Monkey (*Cercopithecus mona* ♀) from West Africa, presented by Col. Makins; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. Palmer; a Vulpine Squirrel (*Sciurus vulpina* ♂) from North America, presented by the Hon. G. Carew; a Malayan Tapir (*Tapirus indicus* ♂) from Malacca, presented by Col. J. M. Jenkins; a Great Eagle Owl (*Bubo maximus*), European, presented by Commander Ernest Rason, R.N.; a Black-crested Cardinal (*Gubernatrix cristatella*) from South America, presented by the Rev. W. B. K. Frances; a Small Hill Mynah (*Gracula religiosa*) from India, presented by Mr. George Grigs; a Long-nosed Crocodile (*Crocodilus cataphractus*) from the River Juba, East Africa, presented by Capt. F. G. Dunbar, R.N.; two —— Tortoises (*Testudo* ——), five Cinixys (*Cinixys* ——), a Puff Adder (*Vipera arietans*) from East Africa, presented by Mr. D. Wilson; a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, an Adorned Terrapin (*Clemmys ornata*) from North America, a Robben Island Snake (*Coronella phocarum*) from South Africa, deposited; a Red Kangaroo (*Macropus rufus* ♀), a Black-fronted Weaver Bird (*Hypotriorchis velatus*) bred in the gardens.

OUR ASTRONOMICAL COLUMN.

PROPOSED SCHOOL OF PRACTICAL ASTRONOMY.—Mr. H. C. Russell, Government Astronomer of New South Wales, in a paper read before the Royal Society of Tasmania, makes some very practicable, and what we think excellent, suggestions with respect to the disposal of the sum of money (£10,000) left by the late Mr. Leake for the foundation of a school of astronomy. The idea is for the Leake trustees to co-operate with the University of Tasmania, and in this way form a complete school in which both the theory and practice of astronomy should be dealt with simultaneously. In addition to the observatory being merely a school for students, Mr. Russell suggests that it should take up some special line of research, and proposes that of astronomical photography. This seems an excellent proposition. The work which such an observatory as this could do if thoroughly equipped with the necessary apparatus, would be very considerable, and the special advantages of climate and position, to say nothing of the unexplored state of the southern heavens, would soon render it of great importance. There is no doubt that we are not yet overburdened with a surplus of observatories in the southern hemisphere, for even now there is a doubt as to how the international photographic chart of the heavens shall be provided for in this region, three observatories which have undertaken the work having been unable to carry out their plans on account of the political troubles. Should this proposal be accepted, the new Leake Observatory will start under good auspices, as it will fill up a gap by taking in hand a share of the greatest modern astronomical enterprise.

DOUBLE STAR MEASURES.—Mr. S. W. Burnham, in *Astronomische Nachrichten*, Nos. 3113–14, gives a list of all the double star measures that he has made during the year 1891 with the 36-inch of the Lick Observatory. Most of the stars here included may be classed as difficult objects, being too close for any smaller aperture, and all of them more or less unequal. As Mr. Burnham tells us, many of the stars are taken from his own catalogues, it being rather important to measure them at this time, since several are in very rapid motion. Owing to the fact that some of these stars have not been measured since the time of their discovery, it is interesting to note the changes that have taken place. Observations of these have "shown some very remarkable changes, and have shown the existence of some of the most remarkable binary systems known." Measurements have also been made of some of the closest and most difficult binaries from the discoveries of Clark, Struve, and others. The epoch for the star places is as heretofore 1880.

COMET BROOKS (1882, AUGUST 27).—From *Edinburgh Circular*, No. 31, we make the following extract of the elements and ephemeris relating to the comet discovered by Mr. Brooks at Geneva on the 27th. The computations are based on four observations made between August 31 and September 5:—

Elements.

T = 1892 Dec. 19·727 M.T. Berlin.

$$\left.\begin{aligned} \omega &= 269^\circ\ 24'\ 27'' \\ \Omega &= 261\ \ 2\ \ 55 \\ i &= 27\ 57\ \ 8 \end{aligned}\right\}\text{Mean Equator, 1892·0.}$$

$$\text{Log } q = 9·84455.$$

Ephemeris for Berlin Midnight.

1892.	R.A. h. m. s.	Decl. ° ′	log. Δ.	log. r.	Br.
Sept. 21	7 2 13	+28 41·6	0·2342	0·2458	2·5
23	7 8 13	28 14·5			
25	7 14 21	27 45·0	0·2105	0·2315	3·0
27	7 20 37	27 13·1			
29	7 27 2	26 38·6	0·1860	0·2166	3·6

The brightness at the time of discovery is taken, as usual, as the unit of Br.

NOVA AURIGÆ.—Some short notes with regard to Nova Aurigæ are communicated to *Astronomische Nachrichten*, No. 3114, which may be of interest here:—On Sept. 3, Dr. F. Ristenpart, of the Observatory in Karlsruhe, with a 6-inch refractor, by comparing the Nova with the brightness of an accompanying star, estimates the Nova as of the 9·65 magnitude of the Bonn scale. Herr Cand. F. Kroeger observed the Nova on three different occasions—Sept. 3, 4, and 6. Comparing it with a neighbouring star of the 9·5m. (Star—Nova = + 3s·5 + 1′·2), the Nova was found to be about "a degree dimmer than the comparison star." On Sept. 4 the seeing was much better, and the Nova was about "two degrees brighter than the comparison star." On the third occasion, with excellent definition, the comparison star and the Nova were of equal brightness. These observations are all made between 12h. and 12h. 30m. Kiel mean time. Prof. E. E. Barnard has also made a very interesting observation with the 36-inch of the Lick Observatory, finding that the Nova appeared as a small, bright nebula, with a *star-like nucleus* of the 10th magnitude. The nebulosity, as he says, "was pretty, bright, and dense, and was 3″ in diameter. Surrounding this was a fainter glow, perhaps half a minute in diameter." If this observation can be verified, it will assuredly strengthen very considerably the hypothesis that the Nova was caused by collisions of meteorites, in the same way as the stars in the Pleiades nebula are the loci of intersecting streams, as clearly shown by Mr. Roberts' wonderful photographs.

ABERRATION PROBLEMS.[1]

EVERYBODY knows that to shoot a bird on the wing you must aim in front of it. Every one will readily admit that to hit a squatting rabbit from a moving train you must aim behind it.

These are examples of what may be called "aberration" from the sender's point of view, from the point of view of the source. And the aberration, or needful divergence between the point aimed at and the thing hit, has opposite sign in the two cases—the case when receiver is moving, and the case when source is moving. Hence, if both be moving, it is possible for the two aberrations to neutralize each other. So to hit a rabbit running alongside the train, you must aim straight at it.

If there were no air that is all simple enough. But every rifleman knows to his cost that though he fixes both himself and his target tightly to the ground, so as to destroy all aberration proper, yet a current of air is very competent to introduce a kind of spurious aberration of its own, which may be called windage; and that he must not aim at the target if he wants to hit it, but must aim a little in the eye of the wind.

So much from the shooter's point of view. Now attend to the point of view of the target.

Consider it made of soft enough material to be completely penetrated by the bullet, leaving a longish hole wherever struck. A person behind the target, whom we may call a marker, by applying his eye to the hole immediately after a hit, may be able to look through it at the shooter, and thereby to spot the successful man. I know that this is not precisely the function of an ordinary marker, but it is more complete than his ordinary function. All he does usually is to signal an impersonal hit; someone else has to record the identity of the shooter. I am rather assuming a volley of shots, and that the marker has to allocate the hits to their respective sources by means of the holes made in the target.

Well, will he do it correctly? assuming, of course, that he can do so if everything is stationary, and ignoring all curvature of path, whether vertical or horizontal curvature. If you think it over you will perceive that a wind will not prevent his doing it correctly; the line of hole will point to the shooter along the path of his bullet, though it will not point along his line of aim. Also, if the shots are fired from a moving ship, the line of hole in a stationary target will point to the position the gun occupied at the instant the shot was fired, though it may have moved since then. In neither of these cases (moving medium and moving source) will there be any aberration error.

But if the *target* is in motion, on an armoured train for instance, then the marker will be at fault. The hole will not point to the man who fired the shot, but to an individual ahead of him. The source will appear to be displaced in the direction of the observer's motion. This is common aberration. It is the simplest thing in the world. The easiest illustration of it is that when you run through a vertical shower, you tilt your umbrella forward; or, if you have not got one, the drops hit you in the face; more accurately, your face as you run forward hits the drops. So the shower appears to come from a cloud ahead of you, instead of from one overhead.

We have thus three motions to consider, that of the source, of the receiver, and of the medium; and of these only motion of receiver is able to cause an aberrational error in fixing the position of the source.

So far we have attended to the case of projectiles, with the object of leading up to light. But light does not consist of projectiles, it consists of waves; and with waves matters are a little different. Waves crawl through a medium at their own definite pace; they cannot be *flung* forwards or sideways by a moving source; they do not move by reason of an initial momentum which they are gradually expending, as shots do; their motion is more analogous to that of a bird or other self-propelling animal than it is to that of a shot. The motion of a wave in a moving medium may be likened to that of a rowing boat on a river. It crawls forward with the water, and it drifts with the water; its resultant motion is compounded of the two, but it has nothing to do with the motion of its source. A shot from a passing steamer retains the motion of the steamer as well as that given it by the powder. It is projected therefore in a slant direction. A boat lowered from the side of a passing steamer, and rowing off, retains none of the motion of its source; it is not projected, it is self-propelled. That is like the case of a wave.

[1] A lecture on "The Motion of the Ether near the Earth," by Dr. Oliver Lodge, at the Royal Institution, Friday evening, April 1, 1892.

The diagram illustrates the difference. Fig. 1 shows a moving cannon or machine-gun, moving with the arrow, and firing a succession of shots which share the motion of the cannon as well as their own, and so travel slant. The shot fired from position 1 has reached A, that fired from the position 2 has reached B, and that fired from position 3 has reached C by the time the fourth shot is fired at D. The line ABCD is a prolongation of the axis of the gun; it is the line of aim, but it is not the line of fire; all the shots are travelling aslant this line, as shown by the arrows. There are thus two directions to be distinguished. There is the row of successive shots, and there is the path of any one shot. These two directions enclose an angle. It may be called an aberration angle, because it is due to the motion of the source, but it need not give rise to any aberration. True direction may still be perceived from the point of view of the receiver. Attend to the target. The first shot is supposed to be entering at A, and if the target is stationary will leave it at Y. A marker looking along YA will see the position whence the shot was fired. This may be likened to a stationary observer looking at a moving star. He sees it where and as it was when the light

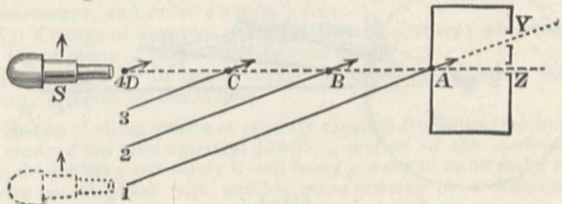


FIG. 1.

started on its long journey. He does not see its present position, but there is no reason why he should. He does not see its physical state or anything as it is now. There is no aberration caused by motion of source.

But now let the receiver be moving at same pace as the gun, as when two grappled ships are firing into each other. The motion of the target carries the point Y forward, and the shot A leaves it at Z, because Z is carried to where Y was. So in that case the marker looking along ZA will see the gun, not as it was when firing, but as it is at the present moment; and he will see likewise the row of shots making straight for him. This is like an observer looking at a terrestrial object. Motion of the earth does not disturb ordinary vision.

Fig. 2 shows as nearly the same sort of thing as possible for the case of emitted waves. The tube is a source emitting a succession of disturbances without momentum. ABCD may be thought of as horizontally flying birds, or as crests of waves; or

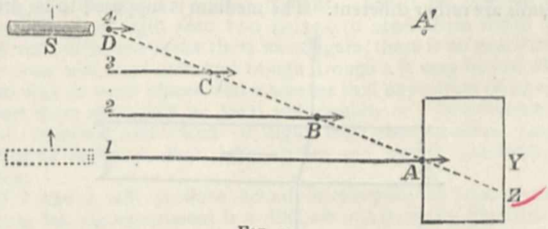


FIG. 2.

they may even be thought of as bullets, if the gun stands still every time it fires, and only moves between whiles.

The line ABCD is now neither the line of fire nor the line of aim: it is simply the locus of disturbances emitted from the successive positions 1 2 3 4.

A stationary target will be penetrated in the direction AY, and this line will point out the correct position of the source when the received disturbance started. If the target moves, a disturbance entering at A may leave it at Z, or at any other point according to its rate of motion; the line ZA does not point to the source, and so there will be aberration when the target moves. Otherwise there would be none.

Now Fig. 2 also represents a parallel beam of light travelling from a moving source, and entering a telescope or the eye of an observer. The beam lies along ABCD, but this is not the direction of vision. The direction of vision to a stationary observer is determined not by the locus of successive waves, but by the path of each wave. A ray may be defined as the path of a labelled disturbance. The line of vision is YA1, and coincides with the line of aim; which in the projectile case (Fig. 1) it did not.

The case of a revolving lighthouse, emitting long parallel beams of light and brandishing them rapidly round, is rather interesting. Fig. 3 may assist the thinking out of this case. Successive disturbances A, B, C, D, lie along a spiral curve, the spiral of Archimedes; and this is the shape of the beams as seen illuminating the dust particles, though the pitch of the spiral is too gigantic to be distinguished from a straight line. At first sight it might seem as if an eye looking along those curved beams would see the lighthouse slightly out of its true position; but it is not so. The true rays or actual paths of each disturbance are truly radial; they do not coincide with the apparent beam. An eye looking at the source will not look tangentially along the beam, but will look along AS, and will see the source in its true position. It would be otherwise for the case of projectiles from a revolving turret.

Thus, neither translation of star nor rotation of sun can affect direction. There is no aberration so long as the receiver is stationary.

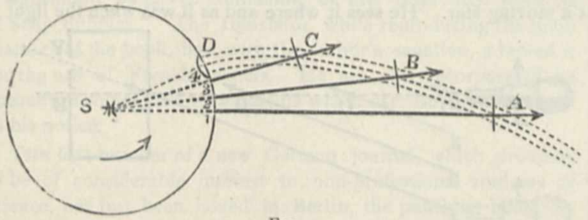


FIG. 3.

But what about a wind, or streaming of the medium past source and receiver, both stationary? Look at Fig. 1 again. Suppose a row of stationary cannon firing shots, which get blown by a cross wind along the slant 1AY (neglecting the curvature of path which would really exist): still the hole in the target fixes the gun's true position, the marker looking along YA sees the gun which fired the shot. There is no true deviation from the point of view of the receiver, although the shots are blown aside and the target is not hit by the particular gun aimed at it. With a moving cannon, combined with an opposing wind, Fig. 1 would become very like Fig. 2.

(N.B.—The actual case, even without complication of spinning, &c., but merely with the curved path caused by steady wind-pressure, is not so simple, and there would really be an aberration or apparent displacement of the source towards the wind's eye: an apparent exaggeration of the effect of wind as shown in the diagram.)

In Fig. 2 the result of a wind is much the same, though the details are rather different. The medium is supposed to be drift-

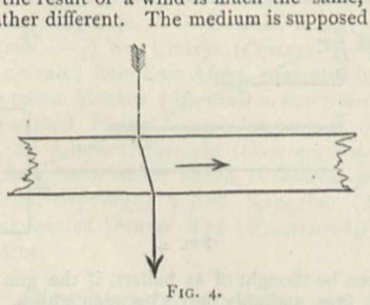


FIG. 4.

ing down across the field opposite to the arrows. The source is stationary at S. The arrows show the direction of waves *in the medium*; the dotted slant line shows their resultant direction. A wave centre drifts from D to 1 in the same time as the disturbance reaches A, travelling down the slant line DA. The angle between dotted and full lines is the angle between ray and wave movement. Now, *if the motion of the medium inside the receiver is the same as it is outside*, the wave will pass straight on along the slant to Z, and the true direction of the source is fixed. But if the medium inside the target or telescope is stationary, the wave will cease to drift as soon as it gets inside, under cover as it were; it will proceed along the path it has been really pursuing *in the medium* all the time, and make its exit at Y. In this latter case, of different motion of the medium inside and outside the telescope, the apparent direction, such as YA, is not the true direction of the source. *The ray is in fact bent where it enters the differently-moving medium* (as shown in Fig. 4).

A slower moving stratum bends an oblique ray (slanting with the motion) in the same direction as a denser medium does. A quicker stratum bends it oppositely. If a medium is both denser and quicker moving, it is possible for the two bendings to be equal and opposite, and thus for a ray to go on straight. Parenthetically I may say that this is precisely what happens, on Fresnel's theory, down the axis of a water-filled telescope exposed to the general terrestrial ether drift.

In a moving medium waves do not advance in their normal direction, they advance slantways. The direction of their advance is properly called a ray. The ray does not coincide with the wave-normal in a moving medium.

All this is well shown in fig. 5.

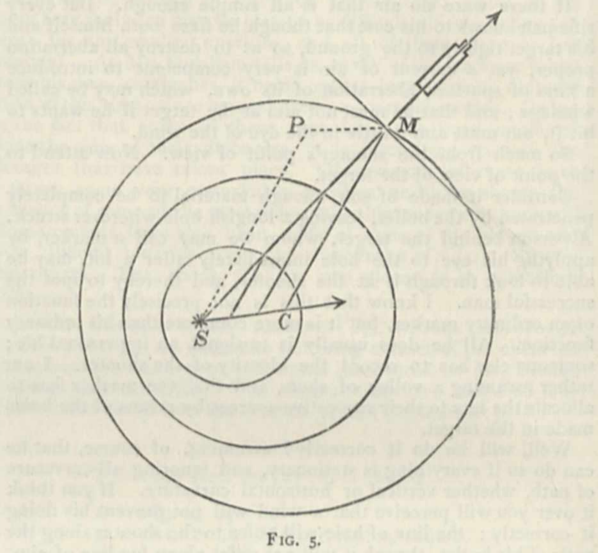


FIG. 5.

S is a stationary source emitting successive waves, which drift as spheres to the right. The wave which has reached M has its centre at C, and CM is its normal; but the disturbance, M, has really travelled along SM, which is therefore the ray. It has advanced as a wave from S to P, and has drifted from P to M. Disturbances subsequently emitted are found along the ray, precisely as in Fig. 2. A stationary telescope receiving the light will point straight at S. A mirror, M, intended to reflect the light straight back must be set normal to the ray, not tangential to the wave front.

The diagram also equally represents the case of a moving source in a stationary medium. The source, starting at C, has

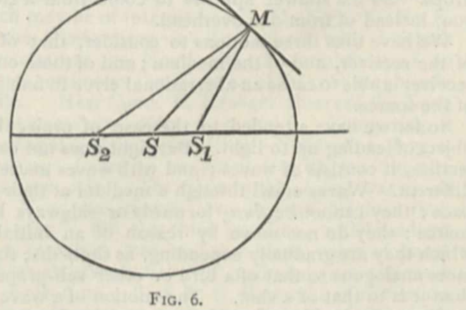


FIG. 6.

moved to S, emitting waves as it went, which waves as emitted spread out as simple spheres from the then position of source as centre. Wave-normal and ray now coincide: SM is not a ray, but only the locus of successive disturbances. A stationary telescope will look not at S, but along MC to the point where the source was when it emitted the wave M; a moving telescope, if moving at same rate as source, will look at S. Hence SM is sometimes called the *apparent* ray. The angle SMC is the aberration angle.

Fig. 6 shows normal reflection for the case of a moving source.

The mirror M reflects light received from S_1 to a point S_2, just in time to catch the source there; as it travels steadily to the left.

Parenthetically I may say that the time taken on the double journey, S_1MS_2, is not quite the same as the double journey SMS when all is stationary, and that this is the principle of Michelson's great experiment referred to below.

For the rest of the lecture I am going to call the medium which conveys light, "ether" simply. Every one knows that ether is the light-conveying medium, however little else they know about the properties of that tremendously important material.

We have arrived at this: that a uniform ether stream all through space causes no aberration, no error in fixing direction. It blows the waves along, but it does not disturb the line of vision.

Stellar aberration exists, but it depends on motion of observer, and on motion of observer only. Etherial motion has no effect upon it, and when the observer is stationary with respect to object, as he is when using a terrestrial telescope, there is no aberration at all.

Surveying operations are not rendered the least inaccurate by the existence of a universal etherial drift; and they therefore afford no means of detecting it.

But observe that everything depends on the etherial motion being uniform everywhere, inside as well as outside the telescope, and along the whole path of the ray. If stationary anywhere it must be stationary altogether. There must be no boundary between stationary and moving ether, no plane of slip, no quicker motion even in some regions than in others. For (referring back to the remarks preceding Fig. 4) if the ether in receiver is stagnant while outside it is moving, a wave which has advanced and drifted as far as the telescope will cease to drift as soon as it gets inside, but will advance simply along the wave-normal; and in general at the boundary of any such change of motion a ray will be bent, and an observer looking along the ray will see the source not in its true position, not even in the apparent position appropriate to his own motion, but lagging behind that position.

Such an aberration as this, a lag or negative aberration, has never yet been observed; but if there is any slip between layers of ether, if the earth carries any ether with it, or if the ether being in motion at all is not equally in motion everywhere throughout every transparent substance, then such a lag or negative aberration must occur: in precise proportion to the amount of the carriage of ether by moving bodies.

On the other hand, if the ether behaves as a perfectly frictionless inviscid fluid, or if for any other reason there is no rub between it and moving matter, so that the earth carries no ether with it at all, then all rays will be straight, aberration will have its simple and well-known value, and we shall be living in a virtual ether stream of 19 miles a second, by reason of the orbital motion of the earth.

It may be difficult to imagine that a great mass like the earth can rush at this tremendous pace through a medium without disturbing it. It is not possible for an ordinary sphere in an ordinary fluid. At the surface of such a sphere there is a viscous drag, and a spinning motion diffuses out thence through the fluid so that the energy of the moving body is gradually dissipated. The persistence of terrestrial and planetary motions shows that etherial viscosity, if existent, is small; or at least that the amount of energy thus got rid of is a very small fraction of the whole. But there is nothing to show that an appreciable layer of ether may not adhere to the earth and travel with it, even though the force acting on it be but small.

This, then, is the question before us:—

Does the earth drag some ether with it? or does it slip through the ether with perfect freedom? (never mind the earth's atmosphere: the part it plays is not important).

In other words, is the ether wholly or partially stagnant[1] near the earth, or is it streaming past us with the opposite of the full terrestrial velocity of nineteen miles a second? Surely if we are living in an ether stream of this rapidity we ought to be able to detect some evidence of its existence.

It is not so easy a thing to detect as you would imagine. We have seen that it produces no deviation or error in direction. Neither does it cause any change of colour or Doppler effect; that is, no shift of lines in spectrum. No steady wind can affect pitch, simply because it cannot blow waves to your ear more quickly than they are emitted. It hurries them along, but it lengthens them in the same proportion, and the result is that they arrive at the proper frequency. The precise effects of motion on pitch are summarized in the following table:—

Changes of Frequency due to Motion.

Source approaching shortens waves.
Receiver approaching alters relative velocity.
Medium flowing alters both wave-length and velocity in exactly compensatory manner.

What other phenomena may possibly result from motion? Here is a list:—

Phenomena resulting from Motion.

(1) Change or apparent change in direction; observed by telescope, and called aberration.
(2) Change or apparent change in frequency; observed by spectroscope, and called Doppler effect.
(3) Change or apparent change in time of journey; observed by lag of phase or shift of interference fringes.
(4) Change or apparent change in intensity; observed by energy received by thermopile.

Motion of either source or receiver can alter frequency, motion of receiver can alter apparent direction, motion of the medium can do neither; but surely it can hurry a wave so as to make it arrive out of phase with another wave arriving by a different path, and thus produce or modify interference effects.

Or again it may carry the waves down stream more plentifully than up stream, and thus act on a pair of thermopiles, arranged fore and aft at equal distances from a source, with unequal intensity.

And again, perhaps the laws of reflection and refraction in a moving medium are not the same as they are if it be at rest. Then, moreover, there is double refraction, colours of thin plates and thick plates, polarization angle, rotation of the plane of polarization; all sorts of optical phenomena.

It may be, perhaps, that in empty space the effect of an ether drift is difficult to detect, but will not the presence of dense matter make it easier? Consider No. 3 of the phenomena tabulated above.

I expect that everyone here understands interference, but I may just briefly say that two similar sets of waves "interfere" whenever and wherever the crests of one set coincide with and obliterate the troughs of the other set. Light advances in any given direction when crests in that direction are able to remain crests, and troughs to remain troughs. But if we contrive to split a beam of light into two halves, to send them round by different paths, and make them meet again, there is no guarantee that crest will meet crest and trough trough; it may be just the other way in some places, and wherever that opposition of phase occurs there there will be local obliteration or "interference." Two reunited half-beams of light may thus produce local stripes of darkness, and these stripes are called interference bands.

If I can I will produce actual interference of light on the screen, but the experiment is a difficult one to make visible at a distance, partly because the stripes or bands of darkness are usually very narrow. I have not seen it attempted before. [Very visible bands were formed on screen by three mirrors, one of them semi-transparent, arranged as in Fig. 7.]

Now a most interesting and important, and I think now well-known, experiment of Fizeau proves quite simply and definitely that if light be sent along a stream of water, travelling inside the water as a transparent medium, it will go quicker with the current than against it. You may say that is only natural; a wind helps sound along one way and retards it the opposite way. Yes, but then sound travels in air, and wind is a bodily transfer of air, hence, of course, it gives the sound a ride; whereas light does not really travel in water, but always in ether. It is by no means obvious whether a stream of water can help or hinder it. Experiment decides, however, and answers in the affirmative. It helps it along with just about half the speed of the water; not with the whole speed, which is curious and important, and really means that the moving water has no effect whatever on the ether of space, though it would take too long to make clear how this comes about. Suffice for present purposes the fact that the velocity of light inside moving water, and therefore pre-

[1] The word "stationary" is ambiguous. I propose to use "stagnant," as meaning stationary with respect to the earth, *i.e.* as opposed to stationary in space.

sumably inside all transparent matter, is altered by motion of that matter.

Does not this fact afford an easy way of detecting a motion of the earth through the ether? Here on the table is water travelling along 19 miles a second. Send a beam of light through it one way and it will be hurried; its velocity, instead

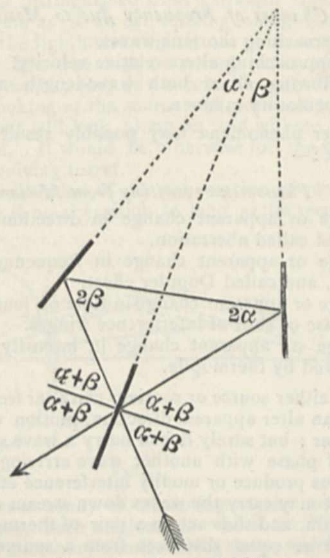


FIG. 7.—Plan of interference kaleidoscope.

of being 140,000 miles a second, will be 140,009 miles. Send a beam of light the other way, and its velocity will be 139,991; just as much less. Bring these two beams together; surely some of their wave-lengths will interfere. M. Hoek, Astronomer at Utrecht, tried the experiment in this very form; here is a diagram of his apparatus (Fig. 8). Babinet had tried another

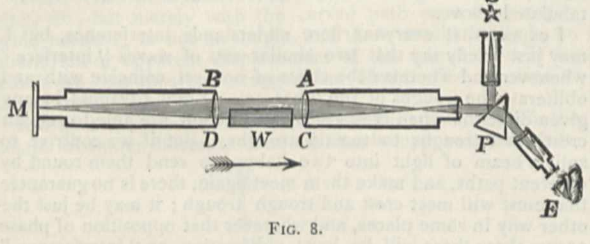


FIG. 8.

form of the experiment previously. Hoek expected to see interference bands, from the two half-beams which had traversed the water, one in the direction of the earth's motion and the other against it. But no interference bands were seen. The experiment gave a negative result.

An experiment, however, in which nothing is seen is never a

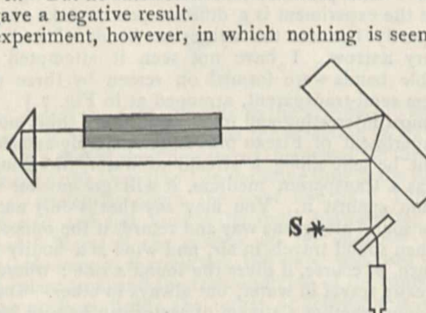


FIG. 9.

very satisfactory form of a negative experiment; it is, as Mascart calls it, "doubly negative," and we require some guarantee that the condition was right for seeing what might really have been in some sort there. Hence Mascart and Jamin's modification of the experiment is preferable (Fig. 9). The thing now looked for is a shift of already existing interference bands, when the above apparatus is turned so as to have different aspects with respect to the earth's motion; but no shift was seen.

Interference methods all fail to display any trace of relative motion between earth and ether.

Try other phenomena then. Try refraction. The index of refraction of glass is known to depend on the ratio of the speed of light outside, to the speed inside, the glass. If then the ether be streaming through glass, the velocity of light will be different inside it according as it travels with the stream or against it, and so the index of refraction will be different. Arago was the first to try this experiment, by placing an achromatic prism in front of a telescope on a mural circle, and observing the deviation it produced on stars.

Observe that it was an *achromatic* prism, treating all wave-lengths alike; he looked at the *deviated* image of a star, not at its *dispersed* image or spectrum, else he might have detected the change-of-frequency-effect due to motion of source or receiver first actually seen by Dr. Huggins. I do not think he would have seen it, because I do not suppose his arrangements were delicate enough for that very small effect; but there is no error in the conception of his experiment, as Prof. Mascart has inadvertently suggested there was.

Then Maxwell repeated the attempt in a much more powerful manner, a method which could have detected a very minute effect indeed, and Mascart has also repeated it in a simple form. All are absolutely negative.

Well, what about aberration? If one looks through a moving stratum, say a spinning glass disk, there ought to be a shift caused by the motion (see Fig. 4). The experiment has not been tried, but I entertain no doubt about its result, though a high speed and considerable thickness of glass or other medium is necessary to produce even a microscopic apparent displacement of objects seen through it.

But the speed of the earth is available, and the whole length of a telescope tube may be filled with water; surely that is enough to displace rays of light appreciably.

Sir Geo. Airy tried it at Greenwich on a star, with an appropriate zenith-sector full of water. Stars were seen through the water-telescope precisely as through an air telescope. A negative result again.

Stellar observations, however, are unnecessarily difficult. Fresnel had said that a terrestrial source of light would do just as well. He had also (being a man of exceeding genius) predicted that nothing would happen. Hoek has now tried it in a perfect manner and nothing did happen.

Since then Prof. Mascart with great pertinacity has attacked the phenomena of thick plates, Newton's rings, double refraction, and the rotatory phenomenon of quartz; but he has found absolutely nothing attributable to a stream of ether past the earth.

The only positive result ever supposed to be attained was in a very difficult polarization observation by Fizeau in 1859. As this has not yet been repeated, it is safest at present to ignore it, though by no means to forget that it wants repeating.

Fizeau also suggested, but did not attempt, what seems an easier experiment, with fore and aft thermopiles and a source between them, to observe the drift of a medium by its convection of energy; but arguments based on the law of exchanges [1] tend to show, and do show as I think, that a probable alteration of radiating power due to motion through a medium would just compensate the effect otherwise to be expected.

We may summarize most of these statements as follows:—

Summary.

Source alone moving produces	A real and apparent change of wave-length. A real but not apparent error in direction. No lag of phase or change of intensity, except that appropriate to altered wave-length.
Medium alone moving, or source and receiver moving together, produces	No change of frequency. No error in direction. A real lag of phase, but undetectable without control over the medium. A change of intensity corresponding to different distance, but compensated by change of radiating power.

[1] Lord Rayleigh (NATURE, March 25, 1892).

Receiver alone moving produces ... ... { An apparent change of wave-length. An apparent error in direction. No change of phase or of intensity, except that appropriate to different virtual velocity of light.

I may say, then, that not a single optical phenomenon is able to show the existence of an ether stream near the earth. All optics goes on precisely as if the ether were stagnant with respect to the earth.

Well then perhaps it *is* stagnant. The experiments I have quoted do not prove that it is so. They are equally consistent with its perfect freedom and with its absolute stagnation; though they are not consistent with any intermediate position. Certainly, if the ether were stagnant, nothing could be simpler than their explanation.

The only phenomena then difficult to explain would be those depending on light coming from distant regions through all the layers of more or less dragged ether. The theory of astronomical aberration would be seriously complicated; in its present form it would be upset. But it is never wise to control facts by a theory: it is better to invent some experiment that will give a different result in stagnant and in free ether. None of those experiments so far described are really discriminative. They are, as I say, consistent with either hypothesis, though not very obviously so.

Mr. Michelson, however, of the United States, has invented a plan that will discriminate; and, what is much more remarkable, he has carried it out.

That it is an exceptionally difficult experiment you will realize when I say that the experiment will fail altogether unless one part in 400 millions can be clearly detected.

Mr. Michelson reckons that by his latest arrangement he could see 1 in 4000 millions if it existed (which is equivalent to detecting an error of $\frac{1}{1000}$ of an inch in a length of forty miles); but he saw nothing. Everything behaved precisely as if the ether was stagnant; as if the earth carried with it all the ether in its immediate neighbourhood. And that is his conclusion. If he can repeat it and get a different result on the top of a mountain, that conclusion may be considered established. At present it must be regarded as tentative.

I have not time to go into the details of his experiment (it is described in *Phil. Mag.* 1887), but I may say that it depends on no doubtful properties of transparent substances, but on the straightforward fundamental principle underlying all such simple facts as that—It takes longer to row a certain distance and back up and down stream than it does to row the same distance in still water; or that it takes longer to run up and down a hill than to run the same distance laid out flat; or that it costs more to buy a certain number of oranges at three a penny and an equal number at two a penny than it does to buy the whole lot at five for twopence.

Hence, although there may be some way of getting round Mr. Michelson's experiment, there is no obvious way; and I conjecture that if the true conclusion be not that the ether near the earth is stagnant, the experiment will lead to some other important and unknown fact.

The balance of evidence at this stage seems to incline in the sense that the earth carries the neighbouring ether with it.

But now put the question another way. *Can* matter carry neighbouring ether with it when it moves? Abandon the earth altogether; its motion is very quick, but too uncontrollable, and it always gives negative results. Take a lump of matter that you can deal with, and see if it pulls any ether along.

That is the experiment I set myself to perform, and which, in the course of the last year, I have performed.

I take a steel disk, or rather a couple of steel disks clamped together with a space between. I mount it on a vertical axis and spin it like a teetotum as fast as it will stand without flying to pieces. Then I take a parallel beam of light, split it into two by a semi-transparent mirror (Michelson's method), a piece of glass silvered so thinly that it lets half the light through and reflects the other half; and I send the two halves of this split beam round and round in opposite directions in the space between the disks. They may thus travel a distance of 20 or 30 or 40 feet. Ultimately they are allowed to meet and enter a telescope. If they have gone quite identical distances they need not interfere, but usually the distances will differ by a hundred-thousandth of an inch or so, which is quite enough to bring about interference.

The mirrors which reflect the light round and round between the disks are shown in Fig. 10. If they form an accurate square the last two images will coincide, but if the mirrors are the least inclined to one another at any unaliquot part of 360° the last image splits into two, as in the kaleidoscope is well known, and the interference bands may be regarded as resulting from those two sources. The central white band bisects normally the distance between them, and their amount of separation determines the width of the bands. There are many interesting optical details here, but I shall not go into them.

The thing to observe is whether the motion of the disks is able to replace a bright band by a dark one, or *vice versâ*. If it does, it means that one of the half beams, viz. that which is travelling in the same direction as the disks, is helped on a trifle, equivalent to a shortening of journey by some quarter millionth of an inch or so in the whole length of 30 feet; while the other half beam, viz., that travelling against the motion of the disks, is retarded, or its path virtually lengthened, by the same amount.

If this acceleration and retardation actually occurs, waves which did not interfere on meeting before the disks moved, will interfere now, for one will arrive at the common goal half a length behind the other.

Now a gradual change of bright space to dark, and *vice versâ*, shows itself, to an observer looking at the bands, as a gradual change of position of the bright stripes, or a shift of the bands. A shift of the bands, and especially of the middle white band, which is much more stable than the others, is what we look for.

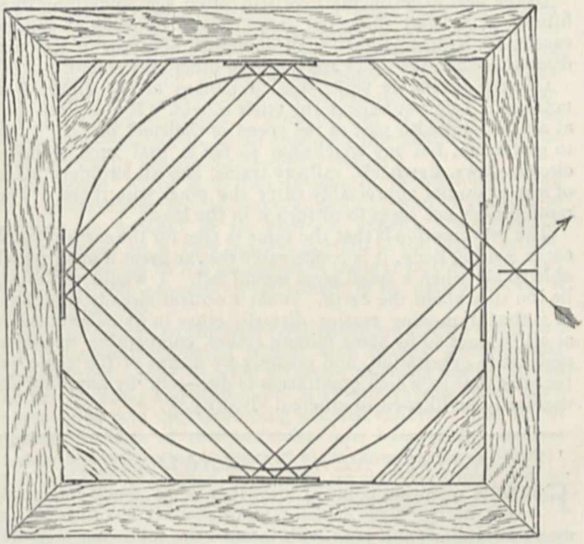


FIG. 10.—Plan of steel disks one yard in diameter, and optical frame; showing the light going round and round, three times each way, between the disks.

At first I saw plenty of shift. In the first experiment the bands sailed across the field as the disks got up speed until the crosswire had traversed a band and a half. The conditions were such that had the ether whirled at the full speed of the disks I should have seen a shift of three bands. It looked very much as if the light was helped along at half the speed of the moving matter, just as it is inside water.

On stopping the disks the bands returned to their old position. On starting them again in the opposite direction, the bands ought to have shifted the other way too; but they did not; they went the same way as before.

The shift was therefore wholly spurious; it was caused by the centrifugal force of the blast of air thrown off from the moving disks. The mirrors and frame had to be protected from this. Many other small changes had to be made, and gradually the spurious shifts have been reduced and reduced, largely by the skill and patience of my assistant, Mr. Davies, until now there is barely a trace of them.

But the experiment is not an easy one. Not only does the blast exert pressure, but at high speeds the churning of the air makes it quite hot. Moreover, the tremor of the whirling machine, in which some four or five horse-power is sometimes being expended, is but too liable to communicate itself to the optical part of the apparatus. Of course elaborate precautions are taken against this. Although the two parts, the mechanical and the optical, are so close together, their supports are entirely independent. But they have to rest on the same earth, and hence communicated tremors are not absent. They are the cause of all the slight residual trouble.

The method of observation now consists in setting a wire of the micrometer accurately in the centre of the middle band, while another wire is usually set on the first band to the left. Then the micrometer heads are read, and the setting repeated once or twice to see how closely and dependably they can be set in the same position. Then we begin to spin the disks, and when they are going at some high speed, measured by a siren note and in other ways, the micrometer wires are reset and read —reset several times and read each time. Then the disks are stopped and more readings are taken. Then their motion is reversed, the wires set and read again ; and finally the motion is once more stopped and another set of readings taken. By this means the absolute shift of middle band and its relative interpretation in terms of wave-length are simultaneously obtained ; for the distance from the one wire to the other, which is often two revolutions of a micrometer head, represents a whole wave-length shift.

In the best experiments I do still often see something like a fiftieth of a band shift, but it is caused by residual spurious causes, for it repeats itself with sufficient accuracy in the same direction when the disks are spun the other way round.

Of real reversible shift, due to motion of the ether, I see nothing. I do not believe the ether moves. It does not move at a five-hundredth part of the speed of the steel disks. I hope to go further, but my conclusion so far is that such things as circular-saws, flywheels, railway trains, and all ordinary masses of matter do not appreciably carry the ether with them. Their motion does not seem to disturb it in the least.

The presumption is that the same is true for the earth ; but the earth is a big body, it is conceivable that so great a mass may be able to act when a small mass would fail. I would not like to be too sure about the earth. What I do feel already pretty sure of is that if moving matter disturbs ether in its neighbourhood at all, it does so by some minute action, comparable in amount perhaps to gravitation, and possibly by means of the same property as that to which gravitation is due—not by anything that can fairly be likened to ethereal viscosity.

NATIVE NEW ZEALAND BIRDS.

FROM a scientific point of view it is of so much importance that native New Zealand birds should be protected that many naturalists will read with interest the following memorandum, which was drawn up by Lord Onslow, the late Governor of New Zealand, and presented to both Houses of the General Assembly by command of his Excellency :—

It is admitted by naturalists that New Zealand possesses in some respects the most interesting avifauna in the world. It is a melancholy fact that, under the changed condition of existence this remarkable avifauna is passing away. Some of the species have already disappeared, whilst others are verging on extinction. Take, for example, the wingless birds of New Zealand. These diminutive representatives of the gigantic brevipennate birds which formerly inhabited New Zealand are objects of the highest interest to the natural historian. The kiwis, like their colossal prototypes the moas, once existed in very considerable numbers in almost every part of the country. At the time of the first colonization of New Zealand, fifty years ago, they were still abundant in all suitable localities. At the present day their last refuges may be indicated on the map without any difficulty. The North Island species (*Apteryx bulleri*) is still comparatively plentiful in the wooded heights of Pirongia and in the bosky groves of the Upper Wanganui. From all other localities where formerly numerous it has practically disappeared. The South Island kiwi (*Apteryx australis*) is now met with in only widely-scattered localities on the west coast. The small spotted or grey kiwi (*Apteryx oweni*), of which perhaps thousands could have been obtained a few years back, has succumbed to the ravages of the stoat and weasel, the persecution by wild dogs, and the necessities of roving diggers, and it is only now to be found in any number along the lower wooded ranges of the Southern Alps. *Apteryx haasti* is one of our rarest species, and *Apteryx maxima* is strictly confined to the wooded parts of Stewart Island.

The kakapo, or ground-parrot (*Stringops habroptilus*), which was formerly so abundant in the wooded country along the whole of the West Coast Sounds and on the western slope of the Southern Alps, is becoming a scarce bird. According to Mr. Richardson, who recently read an exhaustive paper on the subject before the Otago Institute, both the kiwi and the kakapo are now confined to very restricted districts, within which, under the combined attacks of introduced wild dogs and cats, stoats, weasels, and ferrets, they are fast diminishing.

The blue-wattled crow and South Island thrush, which were every-day camp-visitors when Sir James Hector explored the West Coast in 1863, are now very rarely seen ; whilst in the North Island the native thrush and some of the smaller birds have disappeared altogether.

Prominent writers on zoological science, such as Prof. Newton, of Cambridge, Prof. Flower, at the head of the British Museum, and Dr. Sclater, the accomplished secretary of the Zoological Society of London, have over and over again urged the importance of some steps being taken for the conservation of New Zealand birds ; and they have pointed out that it will be a lasting reproach to the present generation of colonists if no attempt is made to save some—if only a remnant—of these expiring forms for the student of the future. Thus, Prof. Newton, in his address to the Biological Section of the British Association, at Manchester, in 1887, saith : "I would ask you to bear in mind that these indigenous species of New Zealand are, with scarcely an exception, peculiar to the country, and, from every scientific point of view, of the most instructive character. They supply a link with the past that, once lost, can never be recovered. It is therefore incumbent upon us to know all we can about them before they vanish. . . . The forms we are allowing to be killed off, being almost without exception ancient forms, are just those that will teach us more of the way in which life has spread over the globe than any other recent forms ; and for the sake of posterity, as well as to escape its reproach, we ought to learn all we can about them before they go hence and are no more seen."

The chief cause of the destruction of native birds is no doubt the introduction of foreign animals, against which the indigenous species are unable to contend successfully in the struggle for existence, especially under the changed conditions of life brought about by colonization. Probably the chief factor in this work of destruction is the Norway rat, whose introduction was of course unintentional, but an inevitable incident of settlement. The insectivorous and other birds introduced (whether wisely or not it is not necessary now to discuss) by our various acclimatization societies have, as it were, driven out and replaced many of the native species. These latter have succumbed to some general law of nature under which races of animals and plants yield to foreign invasion and rapidly disappear, the aboriginal races of man being no exception to this general rule. Where the causes themselves are recondite, it is, of course, difficult to find the means of counteracting them ; but it is an observed law of nature that expiring races survive and linger longest in insular areas. That has been the experience of zoologists all over the world, the islands of Mauritius and Rodriguez presenting a striking instance in point. Here in New Zealand we have many similar evidences. The remarkable tuatara lizard (*Sphenodon punctatum*), supposed to be a survival from a very ancient fauna, and constituting, *per se*, a distinct order of reptilia, which years ago became extinct on the mainland (chiefly through the ravages of introduced wild pigs), still exists in very considerable numbers on the small islands lying off our coasts. The mako-mako, or bell-bird (*Anthornis melanura*), at one time the very commonest of our birds, although still plentiful in the South Island, has absolutely disappeared from every part of the North Island, but it still exists on the wooded islands of the Hauraki Gulf and Bay of Plenty, and on the island of Kapiti, in Cook Strait. The same remarks apply with almost equal force to the wood-robin (*Miro albifrons*) and the white-head (*Clitonyx albicapilla*), two species which have never inhabited the South Island at all. The stitch-bird (*Pogonornis cincta*), which forms a sort of connecting link with the avifauna of Australia, was thirty years ago very plentiful in the woods surrounding Wellington, but it had long before disappeared from the northern parts of the island. It is now extinct all over the mainland, but it exists in comparative plenty on the little Barrier Island—presumably the only locality in the world where this species is now to be found.

All these facts and considerations point to the conclusion that if an attempt is to be made to preserve these and other indigenous species, it must be by setting apart suitable islands for the purpose, and placing them under very strict protective regulations.

Assuming it to be granted that it is the duty of the Government to take the necessary measures, the next question is, what islands are the most suitable for the purpose?

After making careful inquiries on the subject, and reading much that has been written by the Chief Surveyor and other local authorities, I have come to the conclusion that the two best and most readily available islands are the Little Barrier at the north, and Resolution Island at the south.

1. *The Little Barrier.*—This island is still in the hands of the Maoris; but the Government is in negotiation for its purchase, and, as I understand there is only a small amount at issue between the parties, I would strongly urge its immediate acquisition for the purposes indicated. Not only is the Little Barrier known to be the habitat of the stitch-bird, the white-head, the bell-bird, and the native robin (all of which have practically disappeared from the mainland), but it has a wooded surface admirably adapted to the habits of such birds; it is easily accessible from Auckland; it would be difficult for any person to land and shoot birds there without at once attracting the attention of the many ships which are constantly passing in and out of the Hauraki Gulf.

2. *Resolution Island.*—This has now been proclaimed a reserve for native fauna and flora.

(1) Resolution Island is just at a convenient distance from the mainland. It is of considerable extent, with good harbours having deep water and safe anchorage.

(2) Several of the species that it is most desirable to preserve (such as kakapo and kiwi) are known to exist there already in considerable numbers.

(3) It is believed to be the final refuge of the great flightless rail (*Notornis mantelli*), only three specimens of which have ever been obtained in New Zealand, two of these being now in the National Museum, and the other in the Royal Museum at Dresden. One of those in the British Museum (obtained by Mr. Walter Mantell in 1849) was caught by a party of sealers at Duck Cove, on Resolution Island, and the other was captured by Maoris on Secretary Island, opposite to Dea's Cove, Thompson Sound. The third was taken as recently as 1881 by a party of rabbit-hunters in the vicinity of Lake Te Anau. There is every reason to believe that this rare and interesting species still survives on the island which has now been set apart as a permanent Government reserve.

Looking to the interests involved—the great loss to the scientific world implied in the extermination of natural forms that do not exist elsewhere, and the importance, therefore, of saving them—it cannot be denied that a heavy responsibility rests on those who, while there is yet time and opportunity, may neglect to take the necessary steps for their preservation.

All that is wanted to rouse public interest in such a matter is actual knowledge of the facts. There is a strong sentiment always in the public mind against the final extirpation of any living species. As a proof of this one has only to read of the strong public feeling that exists in San Francisco in regard to the protection of the "sea-lions" frequenting the famous Seal Rocks lying off the shore, and of the universal regret with which the Americans regard the almost complete extirpation of the herds of bison, of which at the present day only a small remnant survives under Government protection within certain "reservations." It finds further expression in the lament of all true sportsmen and naturalists on account of the disappearance, through wanton slaughter, of the large game of South Africa. Look, for example, at the quagga, which is now on the verge of extinction. Forty years ago this fine animal might be counted by thousands on every valley and plain of the Cape Colony. At the present day, besides three mounted specimens in European museums, there are two living examples in the Zoological Gardens. Take these away, and the species is blotted out completely.

In urging Ministers to take this subject under their serious consideration I may remind them that on December 16, 1886, the Secretary of the Auckland Institute wrote advising the purchase of the Little Barrier Island as a Government preserve, and that the Premier, Sir Robert Stout, approved of this being done. The purchase was, I believe, strongly advocated by Prof. Thomas and by Mr. A. Reischek, the Austrian collector, both of whom had visited the island and inspected every part of it. At a recent meeting of the Otago Institute a resolution was passed authorizing the Council of that body to move the Government to proclaim Resoluttion Island for this purpose.

Resolution Island having now been so proclaimed, I would suggest that steps should be immediately taken for ascertaining to what extent Resolution Island is already stocked with kiwi and kakapo; that a sufficient supply of these and other birds be at once obtained by purchase or otherwise from the mainland before it is too late, and turned loose both on this island and on the Little Barrier; and that Captain Fairchild (who takes a keen interest in this project) should be instructed to call at these islands from time to time during the periodical cruises of the *Hinemoa*, to ascertain if the birds are thriving, and to report results, with such practical suggestions and recommendations as he may be able to make for the furtherance of this plan of conservation.

I would also, at the same time, suggest that Ministers should take into consideration the propriety of including some other native birds in the list of protected species. As I have already mentioned, the bell-bird, formerly so plentiful, has entirely disappeared from the North Island. But it is still very plentiful all over the South Island, and is a common denizen of the gardens and shrubberies in all the principal towns. This is the bird that so enchanted Captain Cook by its song when his ship lay at anchor in Queen Charlotte Sound more than a hundred years ago, and, having become historical, it would be a grievous pity for the bird to die out altogether. The general testimony goes to show that the protection extended to the tuis had the desired effect, this species being now more numerous everywhere than it was fifteen years ago. Would it not be well to extend the same protection to its small congener the makomako, whose haunts and habits are almost precisely similar?

Then, again, there is a bird famous in Maori history and poetry—remarkable for its singular beauty, and interesting to naturalists on account of its aberrant generic characters—a species confined to a very limited portion of the North Island, from which, owing to the eagerness of natural-history collectors and the inevitable progress of settlement in its native woods, it is fast disappearing.

I refer, of course, to the huia (*Heteralocha acutirostris*), a bird which is naturally confined within such narrow geographical boundaries that I may describe its range as being limited to the Ruahine, Tararua, and Rimutaka Mountain-ranges, with their divergent spurs and the intervening wooded valleys. The white-tipped tail-feathers of this beautiful bird have been from time immemorial the chief adornment of Maori chiefs as head-plumes; and an incident connected therewith, in ancient times, led to the adoption of the name by the great ancestors of the Ngatihuia Tribe.

As Ministers are aware, when selecting a Maori name for my infant son, to commemorate his New Zealand birth, I was induced, for several considerations, to give this name the preference over all others submitted to me; and I should therefore accept it as a compliment to my family if Ministers would exercise the power they possess and throw over this bird the shield of Government protection.[1]

I ask this the more readily on the ground that I have been moved to do so by the chiefs of the Ngatihuia Tribe. At the public function at Otaki, on the 12th September last, when I had the pleasure of presenting my son to the assembled tribes, a number of very complimentary speeches were made by the leading chiefs, and one of them, in referring to the name, said, "There, yonder, is the snow-clad Ruahine range, the home of our favourite bird. We ask you, O Governor! to restrain the pakehas from shooting it, that when your boy grows up he may see the beautiful bird which bears his name."

The huia loves the deep shade of the forest, and as its home is invaded by the settler's axe it would, if protected from reckless destruction, simply retire higher up the wooded ranges, till it finally took refuge in the permanent forest reserve, which embraces all the wooded mountain-tops within its natural domain. Under vigilant protection, therefore, the huia would have every chance of being preserved and perpetuated.

Christchurch, Christmas Day, 1891. ONSLOW.

[1] This has been done: *vide New Zealand Gazette* of February 25, 1892, page 402.

A CENTURY OF SCIENTIFIC WORK.

EVERYONE interested in science is aware that the "Société de Physique et d'Histoire Naturelle de Genève" has won for itself an honoured place among the learned Societies of the Continent. Work of the highest interest and importance has been done by many of its ordinary members, and the list of its honorary members includes a very large number of the investigators who, in different parts of Europe, have contributed most effectually to scientific progress. Some time ago this excellent Society celebrated the hundredth anniversary of its foundation, and an interesting supplementary volume has now been issued in memory of the occasion. To this volume Dr. A. H. Wartmann contributes a sketch of the Society's history, and it may be worth while to note some of the facts he has recorded.

Nominally, the Society was founded in 1790. That is, several men of science in Geneva agreed in that year to unite in forming it. As a matter of fact, however, the first official meeting was not held until 1791. The Society was called at first the "Société des Naturalistes Genevois," and there were eight members, who met in each other's houses on the second and fourth Thursday of every month. The President was M. Gosse. A secretary and a treasurer were appointed; the annual subscription was fixed at two crowns; and an effort was made to obtain copies of the scientific journals of the time. It was felt that there ought to be more than eight members, so the honour of membership was offered to several men of science, by the majority of whom it was accepted. Foreign men of science who happened to be passing through Geneva were invited by the President to attend the meetings, and some of them were made honorary members. In the course of the first year M. Jurine made a present of his herbarium to the Society; this was the origin of its collections. One of the first objects of the Society was the creation of a botanic garden, and a site was chosen which has ever since been retained. M. Micheli presented a hot-house; exotic plants and seeds were obtained; and courses of instruction in botany were given under the Society's auspices by MM. Micheli and de Saussure.

The most eminent representative of science in Geneva at this time was Charles Bonnet. He was asked to become the patron or Honorary President of the new Society. He would have preferred the position of *confrère*, but ended by complying with the request. He died in 1793, bequeathing to the Society 300 crowns, which provided for the maintenance of a gardener and other necessary expenses in the botanic garden.

The activity of the young Society was shown in a series of labours in the physical and natural sciences—labours of which an account has been given by Vaucher, one of the founders. The question of a diploma of reception was raised, and, after much consideration, a seal was prepared. This was abandoned in 1819 in favour of a seal engraved by Bovy.

In 1792 the Society changed its name to "Société Genevoise d'Histoire Naturelle." Shortly afterwards the name by which the Society is still known was adopted.

Under an impulse due to M. d'Albert Henri Gosse, two other scientific Societies were founded in Geneva. One, created in 1803, went back to the name of "Société des Naturalistes." In 1829 it was merged in the "Société de Physique et d'Histoire Naturelle," in whose archives its papers are preserved. Many of these, according to M. Wartmann, are of some importance. The other Society was the "Société Helvétique des Sciences Naturelles," founded in 1815. Of this Society, which has continued to flourish, the "Société de Physique" may be regarded as the Genevese section. When it met at Geneva, in 1866, the two Societies united in the ceremony at the unveiling of a monument to M. Gosse.

When the number of members increased, a fixed place of meeting became necessary. They met for some years at the Société des Arts, then (from 1826) at the Academic Museum, and afterwards (from 1872) in the hall of the Société des Arts. The times of meeting were changed from the second and fourth to the first and third Thursday of every month; and in 1834 it was decided that a meeting should be held only on the first Thursday of the month.

The President holds office for a year. A Vice-President is also appointed. From 1858 to 1879 the President entered upon his duties in July, and in the following June he was succeeded by the Vice-President. Now the President and Vice-President assume office at the beginning of the year.

The Society consists of active members, emeritus members, and honorary members. The former—limited in 1822 to forty, in 1863 to fifty, in 1878 to sixty—reside in the canton. The emeritus members are members who have ceased to take an active part in the Society's work. The honorary members—limited in 1859 to seventy, in 1878 to sixty—are chosen from among men of science in Switzerland or any other part of the world. There are also "associés libres," who cannot be appointed before the age of twenty-five.

Although women do not habitually attend the meetings, there is nothing to prevent them from being connected with the Society. Mrs. Somerville was an honorary member from 1834 to 1873.

Very many communications submitted to the Society have marked important stages in the development of science. At first some of the communications used to appear in foreign periodicals or in the *Bibliothèque Britannique*, which afterwards became the *Bibliothèque Universelle*. In 1820 it was decided that a collection of Memoirs should be issued, and that the task of selecting the papers should be intrusted to a Committee of Publication. This Committee still exists, its secretary being known as the corresponding secretary. The first volume, consisting of two numbers, appeared in 1821 and 1822, and in 1890 appeared the second part of the thirtieth volume. The publication of the Memoirs, many of which are accompanied with plates, is very costly, but sometimes the writers bear the whole or a part of the expense. A *Bulletin*, presenting a *résumé* of the proceedings, has been issued regularly since 1884, and an account has also been given since 1883 in the *Archives des Sciences Physiques et Naturelles*.

The funds of the Society are derived from subscriptions, gifts, and bequests. At first the amount of the annual subscription varied in accordance with the Society's needs, but in 1860 it was fixed at twenty francs. From 1829 to 1854 the Society was officially recognized by the State as the "Société Cantonale de Physique et d'Histoire Naturelle," and received an annual subsidy; but during the last thirty-eight years there has been no relation of this kind between the Society and the Government. A sum of 1200 francs is paid annually by the Administrative Council for the books and memoirs with which the Society enriches the public library of Geneva.

The various collections possessed by the Society have been given partly to the Museum of Natural History, partly to the Botanic "Conservatoire." A prize of 500 francs is offered every five years for the best essay on a genus or family of plants. The sum of 2400 francs which enables this prize to be offered was left to the Society for the purpose in 1841 by A. P. de Candolle. Since 1886 the Society has reserved for itself, at a cost of 600 francs per annum, a place at the Zoological Laboratory of Villefranche, and the person who is to be allowed to take advantage of it is chosen in accordance with a fixed set of rules.

The Society now includes fifty-four ordinary members, four emeritus members, fifty honorary members, and thirty-one *associés libres*. Among the honorary members are many of the most eminent men of science in Europe and America.

THE TRANSMISSION OF ACQUIRED CHARACTERS THROUGH HEREDITY.

THE bearing of insects upon this subject is very clearly brought out by Prof. C. V. Riley in a recently published paper on "Some Interrelations of Plants and Insects" read before the Biological Society of Washington. After dealing with the facts connected with the insects associated with the interesting plants of the genus Yucca and the pollination of their flowers by the Yucca Moth, and touching briefly upon certain aspects of fig-caprification, he makes the following remarks:—

"Now, when it comes to the bearing which the history of these little moths has upon some of the larger questions that are now concerning naturalists (for instance, the transmission of acquired characters, or the origin, development, and nature of the intelligence displayed by the lower animals), broad fields of interesting opinion and conclusion open up before us—fields that cannot possibly be explored without trenching too much upon your time. I will close, therefore, with a few summary expressions of individual opinion, without attempting to elaborate the reasons in detail, and with the object of eliciting further discussion, which is one of the objects of the paper. My first conviction is that insect life and development give no countenance to the Weissman school, which denies the transmission of functionally acquired characters, but that, on the contrary, they furnish the strongest refutation of the views urged by Weissman and his followers. The little moths of which I have been speaking, and indeed the great majority of insects—all, in fact, except the truly social species—perform their humble parts in the economy of nature without teaching or example, for they are, for the most part, born orphans, and without relatives having experience to communicate. The progeny of each year begins its independent cycle anew. Yet every individual performs more or less perfectly its allotted part, as did its ancestors for generation after generation. The correct view of the matter, and one which completely refutes the more common idea of the fixity of instinct, is that a certain number of individuals are, in point of fact, constantly departing from the lines of action and variation most useful to the species, and that these are the individuals which fail to perpetuate their kind and become eliminated through the general law of natural selection.

"Whether these actions be purely unconscious and automatic or more or less intelligent and conscious, does not alter the fact that they are necessarily inherited. The habits and qualities that have been acquired by the individuals of each generation could have become fixed in no other way than through heredity. Many of these acts, which older naturalists explained by that evasive word "instinctive," may be the mere unconscious outcome of organization, comparable to vegetative growth; but insects exhibit all degrees of intelligence in their habits and actions, and they perform acts which, however voluntary and, as I believe, conscious in many cases, as in that of our Yucca Moth, could not be performed were the tendency not inherited. Every larvæ which spins or constructs a hibernaculum, or a cocoon in which to undergo its transformations, exemplifies the potent power of heredity in transmitting acquired peculiarities. A hundred species of parasitic larvæ, *e.g.*, of the family Braconidæ, which in themselves are almost or quite indistinguishable from one another structurally, will nevertheless construct a hundred distinctive cocoons—differing in form, in texture, in colour and in marking—each characteristic of its own species, and in many instances showing remarkable architectural peculiarities. These are purely mechanical structures, and can have little or nothing to do with the mere organization or form or structure of the larva, but they illustrate in the most convincing manner the fact that the tendency to construct, and the power to construct, the cocoon after some definite plan, must be fixed by heredity, since there is no other way of accounting for it. This fact alone, which no one seems to have thought of in the discussion, should be sufficient to confound the advocates of the non-transmissibility of acquired characteristics.

"Thus, to my view, modification has gone on in the past, as it is going on at the present time, primarily through heredity in the insect world. I recognize the physical influence of environment; I recognize the effect of the interrelation of organisms; I recognize, even to a degree that few others do, the psychic influence, especially in higher organisms—the power of mind, will, effort, or the action of the individual as contradistinguished from the action of the environment; I recognize the influence of natural selection, properly limited; but above all, as making effective and as fixing and accumulating the various modifications due to these or whatever other influences, I recognize the power of heredity, without which only the first of the influences mentioned can be permanently operative."

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In Mr. STANFORD'S list attention is drawn to:—A translation into English by Dr. Hatch of Dr. Theodor Posewitz's work on "Borneo: its Geology and Mineral Resources" (the translator has added a number of references and notes, and four new maps accompany the translation); a new book by Mr. Edward North Buxton, being an account of his adventures in pursuit of large game in various parts of the world (it will be entitled "Short Stalks: or Hunting Camps, North, East, South, and West," and will be accompanied by a number of original illustrations); the paper on "The Fayûm and Lake Mœris," which Major R. Hanbury Brown communicated to the recent Oriental Congress, with photographs by the author, diagrams, and a new map; "Castorologia: or the Traditions of a Canadian Beaver," by Mr. Horace T. Martin, of Montreal (the work will be a handsome octavo, with a number of maps and illustrations); "The Partition of Africa," by Mr. J. Scott Keltie, Secretary to the Royal Geographical Society (it will be brought well up to date, and supplied with an excellent apparatus of maps); and new Editions of the following: "Tanganyika: Eleven Years in Central Africa," by Captain Hore; the late Sir Andrew Ramsay's "Physical Geology and Geography of Great Britain," revised by Mr. W. Topley, F.G.S.; Prof. James Geikie's "Great Ice Age," thoroughly revised; and the late Sir Charles Anderson's "Lincoln Guide," revised by the Rev. A. R. Maddison, Librarian and Succentor of Lincoln Cathedral.

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MESSRS. GURNEY AND JACKSON have ready for immediate publication:—"Odorographia," a Natural History of Raw Mateirals and Drugs used in the Perfume Industry, by I. Ch. Sawer, F.L.S.; "The Birds of Lancashire," by F. S. Mitchell, second edition, revised and annotated by Howard Saunders, F.L.S., etc., with additions by R. J. Howard, and other local authorities; a fourth edition of "Destructive Distillation," by Dr. Mills, F.R.S., and a book on "Wild Spain," by Abel Chapman and Walter J. Buck, treating of the beasts and birds of the Peninsula, deer, ibex, chamois, wild boar, and lynx, and bustards, flamingoes, eagles, vultures, game, and wild fowl, with more than 150 illustrations.

MESSRS. SAMPSON LOW AND CO., LIMITED, have in hand:—"The Student's Chemistry," by R. L. Taylor, F.I.C., F.C.S., fully illustrated; and "The Glacial Nightmare," by Sir Henry H. Howorth, M.P., 2 vols.

MESSRS. CASSELL AND CO., LIMITED, announce "The Dawn of Astronomy, by J. Norman Lockyer, F.R.S.; "Beetles, Butterflies, Moths, and other Insects," a brief introduction to their collection and preservation, by A. W. Kappel, F.L.S., F.E.S., and W. Egmont Kirby, with 12 coloured plates; "Cassell's Storehouse of General Information," Vol. III., fully illustrated with high class wood engravings, and with maps and coloured plates; "The Year-Book of Science" (second year of issue), edited by Prof. Bonney, F.R.S., and containing contributions by leading scientific writers; Popular editions of Figuier's works revised by eminent British authorities, "The Insect World," "Reptiles and Birds" (new volumes); and "The Year-Book of Treatment for 1893," a critical review for practitioners of medicine and surgery.

MESSRS. CHAS. GRIFFIN AND CO., LIMITED, will issue "Diseases of the Heart (Diagnosis of)," by A. Ernest Sansom, M.D., F.R.C.P., with 13 plates and illustrations in the text; "Ruptures, a Treatise on," by J. F. C. Macready, F.R.C.S., with numerous plates engraved on the stone after photographs; "Clinical Diagnosis: the Chemical, Microscopical, and Bacteriological Evidence of Disease," by Prof. von Jaksch, of Prague, translated from the third German edition by Jas. Cagney, M.D., with additional illustrations, many in colours, second edition; "The Diseases of Children: Medical and Surgical," by H. Bryan Donkin, M.B., F.R.C.P., and Bilton Pollard, M.D., F.R.C.S.; "Gynæcology," a practical treatise on, by J. Halliday Croom, M.D., with the collaboration of MM. Milne Murray, M.B., and Johnson Symington, M.D.; "Midwifery," a practical treatise on, by John Phillips, M.D.; "A Manual of Obstetrics," for the use of students, nurses, and midwives, by Arch. Donald, M.D.; "Forensic Medicine and Toxicology" (a text-book of), by J. Dixon Mann, M.D., F.R.C.P.; "A Medical Handbook for the Use of Students," by R. S. Aitchison, M.B., F.R.C.P. Edin.; "Inorganic Chemistry" (a Text-Book of), by Dr. Dupré, F.R.S., and Dr. Wilson Hake, second edition, revised; "Mind in Matter," by the Rev. James Tait, third edition, revised and enlarged, with special reference to later Darwinism; "Biology" (a Text-Book of), by Prof. J. R. Ainsworth Davis, new edition, revised and enlarged, in two parts: (1) Vegetable Morphology and Physiology, (2) Animal Morphology and Physiology, with additional illustrations; "Coal Mining" (a Text-Book of), by H. W. Hughes, F.G.S., with frontispiece and 490 illustrations, reduced from working drawings; "Ore and Stone Mining," by Prof. C. Le Neve Foster, D.Sc., with numerous illustrations; "Dyeing" (a manual of), for the use of practical dyers, manufacturers, and students, by Dr. Knecht, Chr. Rawson, and Dr. R. Loewenthal, with numerous illustrations and specimens of dyed fabrics;

"Oils, Fats, Waxes, and Allied Materials, and the Manufacture therefrom of Candles, Soaps, and other Products," by C. R. Alder Wright, D.Sc., F.R.S., with numerous illustrations; "Painters' Colours, Oils, and Varnishes" (a practical Manual), by Geo. H. Hurst, with illustrations; "Applied Mechanics" (an Elementary Manual of), for first year students, by Prof. A. Jamieson, F.R.S.E., with very numerous illustrations; and "Griffin's Electrical Price-Book," for the use of electrical, civil, marine, and borough engineers, local authorities, architects, railway contractors, &c., edited by H. J. Dowsing.

MESSRS. SWAN SONNENSCHEIN AND CO.'s list contains:—"Text Book of Embryology: Man and Mammals," by Dr. Oscar Hertwig, translated and edited from the third German edition by Dr. E. L. Mark, fully illustrated; "Text-Book of Embryology: Invertebrates," by Drs. Korschelt and Heider, translated and edited by Dr. E. L. Mark and Dr. W. M. Woodworth, fully illustrated; "Text-Book of Comparative Geology," adapted from the work of Dr. Kayser, by Philip Lake, fully illustrated; "Text-Book of Palæontology for Zoological Students," by Theodore T. Groom, fully illustrated; "Text-Book of Petrology," by F. H. Hatch, D.Sc., a revised and enlarged edition of "An Introduction to the Study of Petrology," with 86 illustrations; "Handbook of Systematic Botany," by Dr. E. Warming, translated and edited by M. C. Potter, fully illustrated; "Practical Bacteriology," by Dr. Migula, translated and edited by H. J. Campbell, M.D.; "The Geographical Distribution of Disease in England and Wales," by Alfred Haviland, M.D., with several coloured maps; "A Treatise on Public Hygiene and its applications in different European Countries," by Dr. Albert Palmberg, translated, and the English portion edited and revised, by Arthur Newsholme, M.D., fully illustrated; "The Photographer's Pocket-Book," by Dr. E. Vogel, translated by E. C. Conrad, illustrated; "The Recrudescence of Leprosy and the Report of the Leprosy Commission," by William Tebb; "Roaring in Horses: its Pathology and Treatment," by P. J. Cadiot, translated by Thomas J. Watt Dollar, M.R.C.V.S. "Introductory Science Text-Books": additions—Introductions to the Study of "Zoology," by B. Lindsay, illustrated; "The Amphioxus," by Dr. B. Hatschek and James Tuckey, illustrated; "Geology," by Edward B. Aveling, D.Sc. (Lond.), illustrated; "Physiological Psychology," by Dr. Th. Ziehen, adapted by Dr. Otto Beyer and C. C. Vanliew, with 21 illustrations; "Biology," by H. J. Campbell, M.D. "Young Collector Series": additions—"Flowering Plants," by James Britten, F.L.S.; "Grasses," by W. Hutchinson; "Fishes," by the Rev. H. C. Macpherson; and "Mammalia," by the Rev. H. C. Macpherson.

THE SOCIETY FOR PROMOTING CHRISTIAN KNOWLEDGE has nearly ready for publication:—"Star Atlas," gives all the stars from 1 to 6·5 magnitude between the North Pole and 34° south declination and all nebulæ and star clusters which are visible in telescopes of moderate powers, translated and adapted from the German of Dr. Klein, by the Rev. E. McClure, M.A., new edition brought up to date, with eighteen charts and eighty pages illustrative letterpress. "Vegetable Wasps and Plant Worms," by M. C. Cooke, LL.D., illustrated. "Our Secret Friends and Foes," by Prof. Frankland, F.R.S.

MESSRS. LONGMANS AND CO. are preparing for publication:—"The Ruined Cities of Mashonaland: being a Record of Excavations and Explorations, 1891-92," by J. Theodore Bent, F.R.G.S., with numerous illustrations of Mashonaland, and of the author's interesting discoveries of the remains of a prehistoric people at the Zimbabwe ruins. An English translation of Wüllner's "Lehrbuch der Electricität," in 2 vols., translated and edited by G. W. de Tunzelmann, B.Sc., with 310 illustrations. The English editor has added much new matter, and by some changes of arrangement and mode of presenting the subject has endeavoured to make it a truthful representation of the present state of electrical science. "Chemical Lecture Experiments," by G. S. Newth.

MESSRS. LAWRENCE AND BULLEN will publish:—"Matriculation Chemistry," by Temple Orme.

MESSRS. J. AND A. CHURCHILL promise "Physiology" (Student's Guide Series), by E. H. Starling, M.D.Lond., with 100 illustrations; "A Guide to the Science of Photo-micrography," by Edward C. Bousfield, second edition, with 34 woodcuts and frontispiece; "Chemical Technology: or, Chemistry in its application to Arts and Manufactures," with which is incorporated "Richardson and Watts' Chemical Technology," edited by Charles Edward Groves, F.R.S., and William Thorp, B.Sc.: vol. ii. Lighting—Sections: Stearine, by Mr. John McArthur; Candles, by Mr. Field; Oils, Oil Fields, Lamps, by Boverton Redwood; Gas, by Chas. Hunt; Electric Lighting, by Prof. Garnett; "Commercial Organic Analysis," by Alfred H. Allen, F.I.C., F.C.S. A treatise on the properties, proximate analytical examination, and modes of assaying the various organic chemicals and products employed in the arts, manufactures, medicine, &c., with concise methods for the detection and determination of their impurities, adulterations, and products of decomposition. Vol. iii., Part 2, Organic bases, cyanogen compounds, albuminoids, &c. "Wilson's Anatomy," edited by Prof. Henry E. Clark, eleventh edition, with 26 coloured plates, and 492 woodcuts; "Morris's Anatomy," a treatise by various authors: J. B. Sutton, H. Morris, J. N. Davies-Colley, W. J. Walsham, H. St. John Brooks, R. M. Gunn, A. Hensman, F. Treves, W. Anderson, and W. H. A. Jacobson, with more than 500 illustrations, many being coloured; "Ambulance Lectures," to which is added a Nursing Lecture, in accordance with the regulations of the St. John Ambulance Association, by John M. H. Martin, M.D., third edition, with 60 engravings, 142 pp.; and an English edition of Tommasi-Crudeli's well-known work on the Climate of Rome.

Mr. LEWIS'S announcements are:—"Various Forms of Hysterical or Functional Paralysis," by H. C. Charlton Bastian, M.D., F.R.S.; "Diseases of the Skin: Their Description, Pathology, Diagnosis and Treatment," by H. Radcliffe Crocker, M.D., F.R.C.P., second edition, with numerous illustrations; "A Text-book of Ophthalmology," by Dr. Ernest Fuchs, translated from the German by A. Duane, M.D., in one large octavo volume, with 178 illustrations; "Public Health Laboratory Work," by H. R. Kenwood, M.B., with illustrations; "Hygiene and Public Health," by Lucius C. Parkes, M.D., third edition, with numerous illustrations; "A Handbook of the Diseases of the Eye and their Treatment," by Henry R. Swanzy, M.B., F.R.C.S.I., fourth edition, illustrated with wood engravings, colour tests, etc.; "A Pharmacopœia for Diseases of the Skin," edited by James Startin, third edition; and "The Sanitary Inspector's Handbook and Text-book for Students preparing for the Examinations of the Sanitary Institute, London," by Albert Taylor, with illustrations.

Messrs. G. PHILIP AND SON have in the press:—"British New Guinea," a compendium of all the most recent information respecting our Papuan Possession, by J. P. Thomson, with valuable scientific appendix dealing with the Geology, Fauna, Flora, &c., illustrated with numerous engravings and photographs, and a coloured map; "Christopher Columbus," by Clements R. Markham, C.B., forming vol. vii. of the World's Great Explorers and Explorations, with 25 illustrations and numerous coloured maps; "The Development of Africa," a Study in Applied Geography, by Arthur Silva White, illustrated with a set of 14 coloured maps, specially designed by E. G. Ravenstein, F.R.G.S., second edition, revised to April 1892; "Atlas of Astronomy," a Series of Seventy-two beautifully executed Plates, with Explanatory Notes, by Sir Robert Stawell Ball, F.R.S.; "Astronomy for Every-Day Readers," and a Popular Manual of Elementary Astronomy, by B. J. Hopkins, with numerous illustrations.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, Sept. 12.—M. Duchartre in the chair.—On the heat of combustion of glycolic acid, by M. Berthelot.—Note on several new facts relating to the physiology of epilepsy, by M. Brown-Sequard. If by epilepsy is understood a group of reflex convulsive movements, it is invariably induced in guinea-pigs by cutting one of the sciatic nerves. If, however, the section has been made in the lower part of the thigh, the convulsive manifestations often are confined to the side of the lesion, and the animal retains consciousness. This is due to the regeneration of the nerve, which takes place rapidly, and which stops the development of the disease, or even cures it altogether. Generally, the greater the number of nerve fibres severed, the stronger is the tendency towards epileptic fits. A set of absolutely decisive facts have shown that a violent attack can be produced which is due to the spinal marrow alone. This epilepsy as displayed in guinea-pigs is absolutely equivalent to the idiopathic or cerebral disease in man. Clinical as well as experimental facts show that epilepsy has no special seat in the brain, but that all parts of the nervous system, central or peripheral, may give rise to it.—The meadows in the dry summer of 1892, by M. A. Chatin.—Absolute positions and proper motions of circumpolar stars, by M. F. Gonnessiat.—On a problem of analysis involved in the equations of dynamics, by M. R. Liouville.—On a recurring series of pentagons inscribed in the same general curve of the third order, which can be constructed with the sole help of the straight-edge, by M. Paul Serret.—On the calorific distribution of the heat of the sun at the surface of the northern and southern hemispheres of the terrestrial globe, by M. le Goarant de Tromelin. It is sometimes thought that the fact of the sun being eight days longer in the northern hemisphere than in the southern, is the principal cause of the inequality of the distribution of heat in the two hemispheres. It can, however, be shown that the quantities of heat received by two symmetrical elements of the earth's surface, or by two caps symmetrical with respect to the earth's centre, are the same during the durations of the earth's journey comprised between two pairs of opposite vectors. Hence the total heat received by the northern hemisphere during spring and summer is equal to that received by the southern hemisphere during autumn and winter. The true cause of the difference of mean annual temperature in the two hemispheres lies in the difference of loss by radiation. By the law of cooling bodies, if two bodies have the same mean temperature, but different extremes, the one with the greatest extremes will lose most heat by radiation. Thus the southern hemisphere, which is nearer the sun in its summer and further away in its winter than the northern, will lose the greater quantity of heat.—Theory of a condenser interposed in the secondary circuit of a transformer, by M. Désiré Korda.—On the thermal variation of the electrical resistance of mercury, by M. Ch. Ed. Guillaume. The relation between temperature and conductivity was determined by comparing the resistance of a mercury standard of about one ohm at different temperatures with another standard maintained at a constant temperature, with a special arrangement to eliminate the resistances of the contacts. The formula deduced was—

$$\rho_T = \rho_0(1 + 0{\cdot}00088879T + 0{\cdot}0000010222T^2),$$

and the value of the standard mercury ohm—

$$106{\cdot}3 \frac{\text{cm.}}{(\text{microlitre})^{\frac{1}{3}}} \text{ Hg at } 0^\circ.$$

—On a ptomaine obtained from a cultivation of *Micrococcus tetragenus*, by M. A. B. Griffiths. This Micrococcus, found associated with human phthisis, gives rise to a ptomaine if cultivated on peptonised gelatine for several days. This ptomaine is a white solid, crystallizing in prismatic needles. It is soluble in water, giving a feeble alkaline reaction. It forms a chlorohydrate, a chloroaurate, and a chloroplatinate, all crystallizable. Nessler's reagent gives a green precipitate, tannic acid a brown one, slightly soluble. The formula appears to be $C_5H_6NO_2$. It is a poison, and produces death in thirty-six hours. It is undoubtedly the product of the decomposition of the albumin by the microbe.—On echinochrome, a respiratory pigment, by M. A. B. Griffiths. Mr. McMunn discovered a brown pigment in the perivisceral fluid of certain echinoderms in 1883. This was separated by desiccating the fluid and dissolving out by chloroform. The formula of echinochrome is $C_{102}H_{99}N_{12}FeS_2O_{12}$. It serves a purpose in the body of the echinoderm analogous to that of hæmoglobine in the human body, but is not so highly developed as the latter. The respiratory pigments in the lower animals not only carry oxygen to the tissues, but also retain oxygen in combination till taken up by the cellules. Hence echinochrome, like hæmocyanine, chlorocruorine, and similar bodies, is more stable than hæmoglobine.—Physiology of the pancreas, experimental dissociation of the external and internal secretions of the glands, by M. J. Thiroloix.—Influence of some deleterious gases on the progress of anthrax infection, by MM. A. Charrin and H. Roger.—Contribution towards the aseptic method in hypodermic therapeutics, by M. Barthélemy.—On the construction of a luminous fountain with automatically variable colours, by M. G. Trouvé.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Locomotive Engine and its Development: C. E. Stretton (Lockwood).—Universal Atlas, Part 18 (Cassell).—Life Histories of North American Birds: C. Bendire (Washington).—Traité Encyclopédique de Photographie: C. Fabre; Premier Supplément (Paris, Gauthier-Villars).—VI. Jahresbericht (1890) der Ornithologischen Beobachtungsstationen im Königreiche Sachsen: A B Meyer u. F. Helm (Berlin, Friedländer).—Elementary Physiography: R A. Gregory (Hughes).—Dynamometers and the Measurement of Power: J. J. Flather (New York, Wiley).—A Manual of Veterinary Physiology: Veterinary Captain F. Smith (Baillière).—Australische Reise: R. v. Lendenfeld (Innsbruck, Wagner).—Medical Microscopy: Dr. F. J. Wethered (Lewis).—A Dictionary of Terms used in Medicine, &c.: R. D. Hoblyn. 12th edition, revised by J. A. P. Price (Whittaker).—The Sea and the Rod: C. T. Paske and Dr. G. Aflalo (Chapman and Hall).—A Lecture Course in Elementary Chemistry: H. T. Lilley (Simpkin).—Modern Science in Bible Lands, popular edition, revised: Sir J. W. Dawson (Hodder).—A Handy Book for Brewers: H. E. Wright (Lockwood).—Reports from the Laboratory of the Royal College of Physicians, Edinburgh. vol. iv. (Pentland).—The Fauna and Flora of Gloucestershire: C. A. Witchell and W. B. Strugnell (Stroud, James).—Observations of Double Stars made at the U.S. Naval Observatory, Part 2, 1880-91: Prof. A. Hall (Washington).—Experimental Evolution: Dr. H. de Varigny (Macmillan).—Oriental Cicadidæ. Part 6: W. L. Distant (London).—Paraguay: Dr. E. de B. la Dardye (Philip).—Advanced Building Construction (Longmans).—Transactions and Proceedings of the New Zealand Institute, 1891, vol. xxiv. (Wellington).—Sea-sickness, Voyaging for Health, Health Resorts: Dr. T. Dutton, 3rd edition (Kimpton).—Bulles de Savon: C. V. Boys, traduit de l'Anglais par Ch. Ed. Guillaume (Paris, Gauthier-Villars).—Up the Niger: Capt. A. F. Mockler-Ferryman (Philip).—Earth Burial and Cremation: A. G. Cobb (Putnam).—A Vertebrate Fauna of Lakeland: Rev. H. A. Macpherson (Edinburgh, Douglas).—Contributions to Horticultural Literature: W. Paul (Waltham Cross, Paul).

PAMPHLETS.—Music in its Relation to the Intellect and the Emotions: J. Stainer (Novello).—Sadi Carnot et la Science de l'Énergie: M. G. Mouret (Paris, J. Carré).—Appendix to the Catalogue of the Flora of Nebraska: H. J. Webber.—Maryland's Attitude in the Struggle for Canada (Baltimore).—Memorial of J. Lovering (Cambridge, Massachusetts, Wilson).

SERIALS. — Quarterly Journal of Microscopical Science, August (Churchill).—Journal of the Royal Microscopical Society, August (Williams and Norgate).—Transactions of the Academy of Science of St. Louis, vol. v., Nos. 3 and 4 (St. Louis).—Notes from the Leyden Museum, vol. xiv. Nos. 3 and 4 (Leyden, Brill).—Economic Journal, No. 7 (Macmillan).—Journal of Morphology, vol. vi. Nos. 1 and 2 (Boston, Ginn).

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