THURSDAY, MARCH 18, 1886

A TEXT-BOOK OF POLITICAL ECONOMY

A Brief Text-Book of Political Economy. By Francis A. Walker. Pp. iv.-415. (London: Macmillan and Co., 1885.)

PROFESSOR WALKER'S "Text-Book," for the most part an abridgment of the larger work published in 1883, deserves to be received with the highest commendation as supplying a much-felt want in English literature of the subject. An introductory treatment of so complex a study as political economy, written with due insight into the theoretical difficulties of the subject, and at the same time with adequate notice of the practical problems which these involve, can hardly be said to be given in any of the smaller manuals in current use in this country. The praiseworthy work of the late Prof. Fawcett, with its condensation by Mrs. Fawcett, kept on the whole too rigidly to the lines prescribed by Mill's classical treatise, and remained unaffected by many discussions which had shown the need of altering or amending the cardinal doctrines so forcibly stated by Mill. There is hardly any portion of the theory of political economy which has not received attention since the date of Mill's exposition, while the pressure of new practical problems has of itself been sufficient to render necessary some revision of the general theory. Prof. Walker, while retaining on the whole Mill's general conception of the limits and divisions of economical science, has incorporated many results of recent research, and has in addition so keen an eye for practical issues that his exposition, even when remaining within the lines of the older doctrine, gains peculiar freshness and interest.

Of the six parts into which the work is divided, the first contains a brief statement, mainly based on Cairnes, of the character and logical method of Political Economy. Parts II., III., IV., on Production, Exchange, and Distribution, contain an admirable *résumé* of the current doctrine, with certain important modifications. As excellent specimens of the way in which the author's keen appreciation of practical conditions enables him to state economical principles in a novel and forcible manner, I would instance the chapters on labour and productive capacity (Part II., Chapters 2 and 4), that on the reaction of exchange upon production (Part III. Chapter 7), and the treatment of market prices. Opinions must differ in regard to what should be included for purposes of elementary instruction under the three staple heads of production, exchange, and distribution, as also in regard to the most suitable order of treatment. Generally Mr. Walker's choice is wise, and his exposition clear of the more thorny theoretical difficulties. It appears to me, however, that much greater expansion might have been given to the section which follows out division of labour into its concrete form—the specialisation of industries, employments, and localities, and in particular the separation of industrial functions. Without a descriptive basis of some such kind, the student finds far too wide a gap between his hypothetically deduced theory of exchange and distribution and the facts of practical life. More might with advantage have been said on the way in which this social development affects competition, and so some more concrete view of capital obtained than is contained in the chapter on that subject. Justice is barely done to the theoretical notions involved in the determination of normal value, and I think that most useful illustrations of a quite elementary kind are to be had from the treatment of local and temporary variations of price, and of cost of transport or circulation. I am unable to persuade myself that the treatment of seignorage, on which Prof. Walker lays unusual stress, is the best or even a good introduction to the discussion of inconvertible paper money, and generally the sections on money seem to me to leave much to be desired. Possibly the problem of the determination and the variation of general prices is too hard for an introductory treatise, but, if it be omitted, unusual caution is required in laying down abstract propositions regarding demand and supply of money. I do not know how Prof. Walker, usually very careful in his use of terms, will reconcile the statements about "inflation" in §§ 164 and 186. On certain points in the treatment of distribution a remark will later be made.

In Part V. a very interesting and instructive treatment is given of some portions of the theory of Consumption. Prof. Walker seems to me justified in all he says of the importance of this part of the subject. But it has peculiar difficulties, and tends to bring before one rather forcibly the often-recurring doubts as to the economical statics which have preceded it. Perhaps political economy is hardly yet in a position to take the important step of regarding its statics as but a special case of the more general, more important, but less easily formulated dynamical principles.

Part VI.—"Some Applications of Economic Principles"—contains interesting but, on the whole, over-brief treatments of some mixed problems of economics and politics, ranging from usury laws to protection. So far as the book is designed for students beginning the subject, nearly the whole of this part might with advantage have been omitted; it does not seem possible to deal satisfactorily in the compass of a few pages with such involved problems as bi-metallism, progressive taxation, and protection.

The treatment of distribution is the portion of Prof. Walker's work in which he deviates most widely from the current doctrine as laid down in Mill's treatise, in which he tends more towards the view of certain French and German economists. The tendency seems to me to be in the right direction, but not to have been allowed sufficient development, and although I attach high value to this portion of Mr. Walker's work, both in its abridged and its larger form, I cannot think that he has been entirely successful in threading the labyrinth of distribution. It is in the province of distribution that the abstraction by the aid of which the economist proceeds to develop his theorems becomes at once most necessary and most dangerous—most necessary, for there is absolutely no single fixed significance attached to the fundamental terms employed; most dangerous, because the attempt to sever may reduce living reality to a mere economical *caput mortuum.* In the theory of production it is comparatively easy to form the *schema* or general picture of the elements, their relations and movements, which constitute the fact to be analysed; nothing is harder than to form any one self-consistent *schema* of the line within which distribution falls. The common complaint that the fundamental categories of rent, interest, wages, and profits, have in popular usage a meaning not that assigned to them by the economists, only expresses a small part of the difficulty. There is hardly an economical treatment of the subject which altogether evades the consequences of the peculiar difficulty that these terms are indifferently employed to mark the remuneration which, in a hypothetical or actual state of society, falls to distinct industrial functions, and the shares which, in like circumstances, are enjoyed by distinct industrial classes. Hardly anywhere is there sufficient recognition of the important distinction between the proximate and the ultimate conditions through which the distribution of produced wealth comes about. Illustration of these difficulties can be given only from Prof. Walker's excellent and most instructive treatment of profits. Here, following, or at all events coinciding with, some of the best Continental economists, Prof. Walker develops the notion of the *entrepreneur* and his industrial function, and assimilates the remuneration of the *entrepreneur* to rent, from which follow certain important general propositions. Profit, apparently, is regarded as the title of the share falling to the *entrepreneur*. Now, undoubtedly there is a portion of the share falling at any given time to the *entrepreneur* which in its origin and laws is identical with rent, for rent is a quite general consequence of any inequality, howsoever arising, in productive sources at any moment needed for the satisfaction of social wants. But it is impossible to identify this with profit at large, —an identification which Prof. Walker appears to reject in § 255, but which he accepts without qualification in the proposition that there is a class of no-profit *entrepreneurs*. There is doubtless a class of no-profit *entrepreneurs*, but the immediate inference is that the term profit is not equivalent to remuneration of the *entrepreneur*, while it is a further consequence that, in quarters where it has not generally been looked for, there is precisely the same rent-element, in wages *e.g.*, and in payment for the use of capital. What conceals it from us in many cases, and makes it disappear in particular conditions, is the greater perfection of the market for services, which tends to remove the inequalities out of which rent essentially emerges. Prof. Walker's analysis of the *entrepreneur* remuneration seems thus to be far from adequate, though it is on the right track. He has not sufficiently recognised that, if we take *entrepreneurs* as a class, then, by whatsoever name we describe it, their remuneration will be a complex quantity, proximately determined by the conditions under which the exercise of the *entrepreneur* function at any moment meets a social want, ultimately breaking up into a number of distinct remunerations, each having its own natural origin and laws. So with wages. To begin the analysis of wages with the conception of the hired labourer, though it keeps one closer to practice, is only to make a first step, and ought not to conceal from us the essentially complex character of the payment so-called. I believe that fundamentally I am in agreement with Prof. Walker in his view of the ultimate condition determining wages, but I cannot assign such importance to it as he seems to do, and I wish that he had observed his own prudent caution (§ 9) regarding the word property, and not thought it necessary to say (§ 273) that, after deduction of rent, profits, interest, "the whole remaining body of wealth daily or annually created is the property of the labouring class"! This is either one of the many truisms that abound in theoretical economics, or it is a dubious, ambiguous, and incautious rule for practice. It is to be added, however, that Prof. Walker's practical observations about wages in §§ 278–289 are excellent and to the point.

R. ADAMSON

ALGÆ

Till Algernes Systematik. Nya bidrag af J. G. Agardh (Fferde afdelningen). VII. "Florideæ." *Lunds Univ. Årsskrift*, tom. xxi. 4to. (*Proceedings* of the University of Lund, Sweden, 1886.)

FOR more than forty-five years the venerable author —now a septuagenarian—of the work mentioned at the head of this notice, has continued to produce, at brief intervals, a succession of standard works on Algæ. We hope this will not be the last. The present work is a fourth instalment of Dr. Agardh's "Contributions to the Systematic Classification of Algæ." The three preceding parts have been already reviewed in NATURE.[1]

The recent part, which consists of 117 pages, is devoted to the Florideæ. Besides observations elucidating many genera and species already partially known, it contains descriptions of three new genera and between fifty and sixty species. Of the new genera, Titanophora, which belongs to the Nemastomeæ, contains two species—*T. incrustans*, J. Ag. (*Halymenia incrustans*, J. Ag.), and *T. Pikeana* (*Galaxaura Pikeana*, Dickie)—both from Mauritius. The other new genera belong to the Rhodymeniaceæ, namely, Glaphyrymenia, of which there is one species—*G. pustulosa* (see Fig. 4)—and Merrifieldia, which also contains one species—*M. ramentacea*. The last-mentioned alga is one among several instances where the algologist has had to wait many years before he had amassed sufficient material to enable him to give an accurate description of the plant, and to decide on its place in the system. Every one who has collected algæ must know how frequently it happens that plants are dredged or cast ashore in an imperfect state. In some the lower part may be absent; in others the apices of the ultimate branchlets may be broken off; in others, again, the plants may be sterile; or, in the case of the Florideæ, they may bear but one species of fruit. Until, therefore, perfect plants, bearing ripe cystocarps, and others bearing sphærospores, have been thoroughly examined, neither the genus nor the species of the plant can be accurately determined. *M. ramentacea* was first partially described by C. Agardh, in the "Systema," upwards of sixty years ago, under the name of *Chondria ramentacea*, and afterwards by his son, Dr. Agardh, in the "Epicrisis" (p. 661), as *Hypnea ramentacea*. The examination of subsequent examples, with fruit of both kinds, has induced Dr. Agardh to consider this alga as the typical species of a new genus.

[1] The first part, containing a revision of (1) Caulerpa, (2) Zonaria, and (3) certain groups of Sargassum, was published in 1872, in vol. ix. of the *Proceedings* of the University of Lund; the second part, containing (4) Chordarieæ, and (5) Dictyoteæ in vol. xvii.; and the third part, containing (6) Ulvaceæ in vol. xix. of the *Proceedings* of the same University.

In Fig. 5 the cystocarps and sphærospores, in different degrees of development, are represented.

Two other genera at present but little known, namely, Marchesettia (Hauck) and Melanoseris (Zan.), are also commented on. The former is a most singular alga, in appearance much more like a branched sponge than a plant, and, except for the little deep-red fruit-leaflets, it might readily be taken for one. The discovery of the fruit shows that its affinities are with Thamnoclonium. One of the several new species of this genus, described in the present work, so much resembles Marchesettia, that it has been named *T. Marchesettioides.*

The other genus, Melanoseris, is nearly related to Pollexfenia, from which it is distinguished by the fruit in the former being marginal, instead of on the disk, as in the latter, and by its smaller size.

Halymenia saccata (Harv. and H. "Fl. Tasm.") has long been a puzzle to algologists. Dr. Agardh now refers it to Bindera, supporting his opinion by a comparison of the structure and fruit with those of *Bindera splachnoides* (see pp. 41-46, and Fig. 3).

Another plant, *Amansia? Marchantioides*, first mentioned in the "Flora of New Zealand," had not, hitherto, been accurately determined. Dr. Agardh now considers it to be a Placophora.

Among the more interesting of the new species is *Cliftonæa imbricata*, of which one specimen only has yet been discovered. This was also the case with *C. semipennata*, of which one example only is known to exist.

The present work is illustrated by one plate. The eight figures are printed in a red ink, which is somewhat dazzling to the eyes.

In conclusion, we venture to suggest that *Gracilaria Millardetii* (p. 64) should be *G. Maillardetii*, the plant having been named by Montagne *Rhodymenia Maillardetii*, in honour of M. Maillard, the author of "Notes sur l'Ile de Réunion."

OUR BOOK SHELF

Practical Chemistry, with Notes and Questions on Theoretical Chemistry. By William Ripper, Assistant Professor of Mechanical Engineering, Sheffield Technical School. Second Edition. (London: Isbister and Co., 1885.)

TRULY the number of little books coming into existence, presumably to aid students to do the Science and Art Department's examinations, is very great, and they are not by any means always good. The evil of a big book has evidently been well seen by chemical teachers, and more especially by teachers connected with the Department's examinations, many little books springing up intended originally for the class or school to which the teacher is attached only. In some, the greater number of cases perhaps, this is a very happy thing for students in general. When a book of this kind passes through two editions in a reasonably short time there is some cause for its survival. The book before us has evidently fulfilled its mission in a fairly satisfactory manner. It is still decidedly one of the cramming class, but it contains an amount of matter simply and well arranged which, with the aid of a teacher, or demonstrations, should enable any ordinarily industrious student to "pass" the first stage of the "Department's" examinations.

The first part contains descriptions of experiments on the non-metallic elements, reactions for metals and acids, and tables for the examination of a simple salt. The second part, called "Theoretical Chemistry," is mostly equations, and questions and problems.

Free Public Libraries; their Organisation, Uses, and Management. By Thomas Greenwood, F.R.G.S. (London: Simpkin, Marshall, and Co., 1886.)

IF in Her Majesty's dominions there is a spot where newspapers do not penetrate and where free libraries are only known by name, *and yet* where some pioneering spirit only requires a spark to set aflame the desire to start such an institution, this book will be a fitting flint and steel for the purpose. But as such a combination is to be found in very few places, we cannot encourage the writer to hope that many will read his 500 pages of newspaper cuttings with much satisfaction. To any *reader* who is within measurable distance of earnestly considering that "most interesting question of the day—how to work a free library in a small community"—nine-tenths of this book, commencing its survey as it does at the British Museum, will be provokingly irrelevant; he will grudge the time taken up in finding where the practical information is scattered. As a missionary book, crying in the wilderness the advent of knowledge, it is less likely to make its way than the newspapers from which it is compiled, and it is thoroughly wanting in the eloquent earnestness of the prophet.

Still there is much excellent advice to those who know nothing about the matter; and since it seems to have been written, as the compiler says, "with the earnest hope of increasing the number of free libraries" (there are 133 now open in Great Britain) we gladly call to it the attention of any to whom such a book as we describe may be useful. The combination in the writer of librarian and newspaper editor has made easy to him much that would have been a considerable labour to others who might have gone more deeply into the subject, and his information is brought down to marvellously recent date.

The hasty way in which it has been put together is illustrated by an account on p. 83 of "first failures," which apparently apply to Sheffield, and are not discovered to belong to Newcastle-upon-Tyne till three pages further on there comes a full-page engraving of the important building opened there in 1884 by the Prince of Wales. A puzzled reader may guess that a short paragraph on p. 100 should have introduced its history, but that it found its present place among the author's notes through confusion of the name with that of Newcastle-under-Lyme. The same haste appears in more important matters. Mr. Greenwood very properly urges the importance of the librarian as the "vocal key to the catalogues," and gives a touching illustration of the value of knowledge and sympathy in that officer. "Wives and children come for books, and make the request, 'Please pick me a nice one, sir, for if I take home an interesting book, my husband (or father, as the case may be) will stop in during the evening and read it to us.'" We must point out the inconsistency between this and the unqualified advice he gives to the librarian not to stand "at the desk entering out and taking in the books, and so uselessly employed in doing the work of a boy." It will be found that as such a librarian stands at the counter and hears the wants expressed of the class for whose benefit chiefly these libraries are considered to be established, the circulation of books will increase; while if it is left to a boy to do the work, the popularity, the circulation, and to a far greater extent the good work, of a free library will fall off. The same consideration also should qualify the zeal with which the use of indicators is urged, which, though theoretically very simple, and to the library officials very time-saving things, yet practically do not work where any attempt is made to accommodate the class just referred to, or an unlearned public who, it will be found, *won't* use catalogues. For one minute, however, which they save the librarian, they hinder five minutes of the borrower of the more intelligent class; to whom, also, the most recent catalogue (and hence the indicator) is generally deficient of three-fourths of the books he most wants, viz. the new ones.

Nothing is better than the advice given here to secure a good librarian even at a higher cost than some may consider proportionate to the income. But the committee having taken that advice, there is little in this book which will be of value to either him or them. W. ODELL

Les Aérostats dirigeables. Par B. de Grilleau. (Paris: Dentu, 1884.)

THIS little book does not add anything to the scientific data regarding the direction of balloons which we have lately published; indeed it was written before the best and most conclusive trials were made. It is a popular view of the subject only; but it is useful as combating the ignorant prejudice existing thereon in the public mind. It points out to whom the successful solution of the problem is due; it states the results that have been obtained, and it shows what may be expected to be done in the future. It also explains clearly some of the conditions affecting the question, which are often misunderstood, such as the effect of the wind, the effective speed obtainable, the nature of the propelling action, and so on.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Clifford's "Mathematical Fragments"

A SHORT time since I lent the originals of this work to Mr. A. B. Kempe, F.R.S., as he has been working on the subject of "graphs." Some remarks he made on returning the "Fragments" led me to compare them with the lithographed work, and I propose to supply what is, I think, a defect in the published book.

The "Mathematical Fragments" are reproduced on xxii. pages of a *uniform* size which in the original manuscript is that of the first 5 pages only. The paper of these pages is blue, and has ruled lines. Page vi. corresponds to *two* pages of manuscript, indicated by a break, two other pages being blank. Page vii. corresponds to two *distinct* pages of manuscript. Page viii. is made up of three parts, the first six lines on one page of manuscript, the next thirteen of another page of manuscript. These last pages of plain white paper are approximately 4½ inches wide by 5½ inches deep. The page is filled up with a fragment on plain blue paper approximately 5¼ by 8 inches. Page ix. is on stout plain white paper, app. 7 inches by 9 inches. The last five lines of book are written on the back of the paper. Pages x.-xvi., xviii.-xxi. are written on thin white paper of the same material as page vi., size 9 inches by 11 inches; the pages are all *detached*; page 15 is on back of page 14, and page 19 on back of page 18. Page xx. is made up of two distinct pages of manuscript, the second commencing at the defaced word which is clearly in the manuscript "Degree." Page xvii. is written in pencil on stiff white paper, folded in half, the lower fragment in the manuscript being in the lower half of the page, and at right angles to the upper—size of full page, app. 7 inches by 10 inches. Page xxii. is made up of three pages of manuscript: the uppermost fragment is on white paper, 6 inches by 4 inches; the immediately following four lines of writing are given on the back of this page. The next three lines are on paper 7 inches by 10 inches, and the last four lines on precisely similar paper. The time notes at the side have, of course, nothing to do with "graphs."

These "Fragments" have been circulated (see "Papers," p. 286) chiefly amongst libraries; if the details I here supply are indicated in the copies, their value will, I believe, be greatly increased, and much trouble may be saved by students when they know how slender a connection there is in some cases between consecutive pages of the text. In the manuscript there is no indication of the order in which the pages should be read beyond what I have pointed out above. The manuscripts are now deposited in the Library of University College, Gower Street. R. TUCKER

The Upper Wind Currents in the South Indian Ocean and over the N.W. Monsoon

AFTER sending a brief account to NATURE of my observations on the upper wind currents over the Atlantic doldrums, I started from Natal for some journeys across various portions of the Indian Ocean, to investigate the circulation of the higher atmosphere in that region.

I first went to Mauritius. During the whole passage from Natal, at the end of December, we sailed in the S.E. Trade, with an almost constant movement of high cirrus from the N.W.

Though I was disappointed in not meeting with a cyclone in those seas, still I succeeded in obtaining much valuable information about the details of hurricane weather, which could only be learnt on the spot. One point relating to upper currents is very important. The cirrus which appears five or six days before the arrival of a hurricane follows the normal course from N.W. or S.W., and is no guide to the path of the cyclone. But on the outskirts of the hurricane, low clouds afford valuable information. If the cloud over the S.E. surface-wind inclines towards E. the centre of the cyclone will pass to the N.; if on the contrary the low cloud inclines towards S. the centre will pass to the S. of the observer.

Though Meldrum, and Bridet of Réunion, both agree on this point, the subject requires further elucidation, for such a rotation of upper currents is contrary to all analogy of what is supposed to hold round cyclones in the northern temperate regions. I am certain from my own investigations that the general character of tropical and extra-tropical cyclones is identical. In Mauritius hurricanes I find the same oval form, the same squall at the turn of the barometer, the same halo in front, and hard, detached cloud in rear, which characterise European cyclones. Mr. Harris has recently traced a cyclone from its easterly course as a typhoon in the China Seas, across the Pacific, United States, and Atlantic into Western Europe. Like every other long-lived cyclone, this one received accessions of strength by fusion or coalescence with others which had formed outside the tropics. It is perfectly certain that cyclones which revolved on different systems could not unite, and I think that the motion of the lower layers of cloud over the northern side of our own cyclones should receive special attention. At present we are led to believe that the cirrus in front of a cyclone, both right and left of the path, comes from S.W. or S.

Be this as it may, cloud motion forms a useful adjunct to a valuable and successful system of hurricane forecasting that is carried out by Mr. Meldrum, who, in the absence of telegraphs, has to rely entirely on his own instruments and above all on his own experience and judgment. Another interesting feature of this system is the care which must be taken to allow for the diurnal motion of the barometer during the slow diminution of pressure which always precedes the arrival of a hurricane.

From Mauritius I sailed to Adelaide, so as to examine the Polar limit of the S.E. Trade. Though we steered a great circle course which took us fully into 39° S. latitude, we experienced constant S.E. and E. winds. These must have been due to some extra-tropical anticyclone, and every observation of low or middle layers of cloud showed a current practically in the same direction as the surface-wind.

At Adelaide I learnt that the normal direction of the highest currents is from N.W. In that city the direction of the surface-wind is much influenced by land and sea breezes. Through the kindness of the acting chief of the Observatory, Mr. W. E. Cooke, I was able to confirm what I had previously suspected from my investigations in Melbourne last year, that sometimes at least the characteristic "southerly bursters" of Australia, are due to that class of V-shaped depression in which the rain occurs in rear of the disturbance. Other times the sudden irruption of S. wind appears due to the shift of wind at the passage of the trough of a cyclone.

From Adelaide I came here to Colombo so as to repeat a section of Indian Ocean very nearly at the same season and in the same straight line as last year. The results of the former voyage were communicated to NATURE, vol. xxxii. p. 624, when I announced the fact that the highest currents over the

N.W. monsoon came from points of E., and not from W., as might have been anticipated.

In this journey I found the clouds at the Polar side of the S.E. Trade coming constantly from a point either side of the surface-wind, that is, from S.S.E. to E.S.E. When well in the Trade, the middle clouds always came from some point more east than the surface-wind, or in accordance with the usual circulation of the southern hemisphere. No high cirrus was ever observed.

We found no doldrum, but ran straight from the Trade, under a bank of cloud, into the N.W. monsoon, in about 12° S. latitude. In that monsoon the low and middle clouds always came a little more from the N. than the surface N.W. wind, or in the manner of the upper winds of the northern hemisphere. All the high cirri moved from E. or N.E., except on one occasion, when they came from S.

The N.E. monsoon which we picked up on the equator was so clear that I only obtained one observation of cirrus which came from N.E. when the surface-wind was N.N.E. The lower layers of cloud usually drove from the same direction as the surface-wind, though on one or two occasions they came from a point more N. than the surface.

The above results entirely confirm the observations described in my previous letter of a deep S.E. Trade and of an easterly current over the N.W. monsoon. RALPH ABERCROMBY

Colombo, February 15

Glacier Bay in Alaska

I THANK your correspondent, Mr. Chauncey Thomas, for pointing out my error in describing Glacier Bay as opening into Chilcoot Inlet, and for more exactly indicating its position. When I visited this region I was provided only with a small and inaccurate pocket-map, in which I found it difficult even to trace the course of the steamer, and I was under the impression that the whole of the fiord northward from Chatham Strait was known as Chilcoot Inlet, though my statement would still not be quite correct.

It may be well to add that my object in arranging my rough field-notes for publication was not to describe the glacier as a whole, but to draw attention to some uncompleted observations of special geological interest which it seemed to me ought to be made known as indications for future explorers; and it should be borne in mind that my estimates of heights and distances were only estimates based on opinion, and not on any system of actual measurement. The very limited time at my disposal, and my desire to get over as much ground as possible in that time, precluded the use of more satisfactory methods.

Bridlington Quay, March 13 G. W. LAMPLUGH

A Correction, and the Distribution of Appendicularia

(1) THE specimen which I referred to in NATURE (Jan. 7, p. 221) as being probably a new species of *Chætoderma*, has turned out on a more detailed examination not to be Chætoderma at all. Therefore I must withdraw the statement that that genus has been found in British seas.

(2) Can any of your readers who have been using the tow-net round our coasts give me information in regard to the occurrence of the Appendiculariidæ? Forbes and McAndrew found *Appendicularia* off the north coast of Scotland in 1845. Allman found it in the Firth of Forth in 1858, and Sanders at Torquay, 1873; and it has been taken by Huxley on the English coast. It was seen in quantity by Sorby off the south coast of England a couple of summers ago, and I obtained it in Lamlash Bay in 1880 and 1884, in Loch Fyne in 1883, and off the Mann coast in 1885. Apparently it is much commoner and more generally distributed than is usually supposed. I would be glad to hear of any additional records of the occurrence of the Appendiculariidæ in our seas. W. A. HERDMAN

University College, Liverpool

Morley's "Organic Chemistry"—Correction

IN my notice of Dr. Morley's "Organic Chemistry" in this week's NATURE, the reference to "Ladenburg's synthetic optically-inactive coniine (α-isopropylpiperidine)" (p. 436) contains an inaccuracy. Instead of "coniine" it should read "coniine-base." F. R. JAPP

Normal School of Science, March 11

"Peculiar Ice-Forms"

IN NATURE, vol. xxxi. p. 5, you allowed me to describe, under this heading, a curious and beautiful form of fibrous ice met with near Chamonix, which I, and other of your correspondents who discussed the matter, thought to be very unusual, though later communications seemed to show that it is commoner than we had supposed.

It may be interesting to note that a day or two ago I came upon the same form of ice in considerable quantity in a very unexpected locality, viz. on the path leading from Gerozano to Lake Nemi, in the Alban Hills. Attention was drawn to the circumstance by the crackling of the ice under foot, otherwise there was no visible indication of its presence except that, where it existed, the path was slightly damp (which was not the case on other parts of it), the dampness being evidently due to the partial melting of the upper stratum of the ice, which was everywhere covered with a layer of earth. The ice was almost exactly similar to that found at Chamonix, but only an inch and a half to two inches deep, and in three layers, easily detached from one another, and evidently the result of successive frosts.

We afterwards found that a bank beside the road between Albano and Frascati was covered with the same formation for several hundred yards; but it would certainly have escaped detection, being everywhere covered with earth, if our previous discovery had not led us to recognise it. This proves that it may often exist unnoticed.

The conditions were precisely similar to those under which this particular form of ice has been observed before—viz. a northerly aspect—a very porous soil (in this case volcanic), bright, sunny days, and clear nights with a low temperature.

Rome, March 12 B. WOODD SMITH

REMARKABLE DISCOVERY OF RARE METALS IN DILUVIAL CLAYS [1]

DR. STROHECKER, of Frankfort, has carefully examined and analysed the clay which is found in the neighbourhood of Hainstadt, near Seeligenstadt, and he has made the remarkable discovery that this clay, which has been largely used for building purposes, contains considerable quantities of some of the rare metals, and more especially cerium. The beds are extensive, and consist of layers differing considerably in appearance and composition.

The composition of picked samples of the two upper layers is as follows:—

	No. 1	No. 2*a*
SiO_2	47·5444 ...	58·3331
TiO_2	trace ...	—
Al_2O_3	24·5937 ...	11·7607
BeO	6·4399 ...	5·3833
Fe_2O_3	0·9190 ...	0·6356
$Ce_2(OH)_6$	13·4214 ...	9·4012
DiO	— ...	0·8474
LaO	0·8576 ...	2·6536
YO	— ...	1·6949
MgO	1·5901 ...	1·8659
$CaCO_3$	0·8878 ...	—
$CaSO_4$	0·1361 ...	0·2015
CaO	— ...	0·5883
P_2O_5	trace ...	2·0691
K_2O	2·3236 ...	0·5648
Na_2O	1·2137 ...	0·5838
NH_4Cl	— ...	0·0529
Loss on ignition ...	— ...	4·1057
	99·9273	100·7418

The cerium and yttrium oxides appear to be derived from orthite, which is known to occur in the syenite at Weinheim. The upper layer (No. 1) of the clay varies in colour from a bright flesh-colour to a dark cinnamon-brown, indicating that the cerium hydroxide, which is the colouring substance, varies in amount at different points. The bricks made from this clay vary in colour according to the temperature at which they are burnt, the lightly-burnt bricks having an orange-yellow colour, whilst those

[1] *Journal f. prakt. Chemie*, 1886, pp. 132 and 260.

burnt at a white heat are leather-coloured, and have a silver-gray appearance.

The second layer (No. 2) is divided into two varieties, *a* and *b*, the former of which is black from the presence of lignite, and yields lemon-yellow bricks; this colour is due to the conversion of the cerium oxide Ce_2O_3 into the lower oxide Ce_3O_4 by the action of the carbon which is present. The *b* variety is blackish-gray, and yields orange-red to orange-yellow bricks.

The third layer contains less cerium than the other two, and the bricks made from it are of a fainter orange colour.

The amount of glucina present is very characteristic of the Hainstadt clay. Ammonium chloride, which occurs only in traces in some portions of the clay, exists in quantity in others; and in one piece which crumbled to pieces a crystal of sal-ammonia was found measuring about 2 centimetres in length and 1·5 centimetres in thickness.

It will be seen from the above that the oxides of cerium which were hitherto of only theoretical interest, are now of technical importance. They have long served as colouring substances in building materials without the fact having been known, and from the large amount present in the Hainstadt clay there are prospects of their being brought into use as paints.

The variation in the colour of the bricks, already mentioned as being produced according to the degree of heat to which they are submitted in the process of burning, does not appear to be due to any action of the silicate on the ceric oxide, as the latter substance can itself be made to assume either colour by igniting it at a suitable temperature. The small amount of iron present in the clay is found to have no influence on the colour of the bricks, which however is affected by the admixture of larger quantities of iron. Dr. Strohecker mentions a number of streets in Frankfort in which houses constructed of the different sorts of cerium bricks are to be seen; the leather-coloured bricks occur in Palmstrasse, Bergerstrasse, Schleidenstrasse, Schillerplatz, Goetheplatz, &c.; the orange-red bricks at the police-station, the law-courts, and in the walls of the zoological garden, &c., and the lemon-yellow bricks at a villa near the west station at Hanau, and at a house in the Verlängerte Zeil at Frankfort. The houses of the peasants near Hainstadt are built of lightly-burnt bright flesh-coloured and yellow bricks.

The somewhat remarkable fact that chemists have so long failed to recognise anything other than ferric oxide as the cause of the colours in these bricks may probably be explained by the large number of shades of colour produced by iron in its various stages of oxidation, by the presence of manganese, and by the employment of mixed clays containing the oxides of both cerium and iron.

HARVARD COLLEGE MUSEUM REPORT

PROF. AGASSIZ' Report, dated October 1885, has just reached us, and, as usual, it presents several topics of interest. Since the first section of the Museum was inaugurated in November 1860, the establishment has passed through many changes, and from being, at its origin, a State institution, it has gradually assumed that of an independent department of the Harvard College. While it has thus lost the immediate support of the State, it has gained the good will and interest of the students of the College, the class upon whom it must in a very great measure depend not only for its maintenance, but for its being a source of intellectual and scientific good.

During the first decade of its existence the resources of the Museum were spent in forming collections which, in some branches of science, have made it a great scientific centre. During this period of ingathering the teaching powers of the place were interfered with. Now this period has so far passed that the resources of the place will be chiefly expended on its teaching, its original investigations, and its publications.

The foundation of this Museum dates from the publication of the "Origin of Species." The powerful movement effected by this work on the scientific thought of the age has not failed in modifying the problems which this institution was intended by its original founder to illustrate and to solve; and rightly does the son write that, if the synoptic, systematic, faunal, or palæontological collections should cease to bear the interpretation given to them by his father (the founder), their interest and importance for the advocates of the new biology would not be one whit lessened.

It is pleasant to note that the plans of Prof. Louis Agassiz—the founder of the Museum—have been, it is known, realised, and indeed beyond his most sanguine expectations, and that his son and successor now sees the establishment of a prosperous School of Natural History, amply provided with laboratories, connected with a University, and recognising in the administration of its trusts the claims of the College and of the advanced students, as well as those of the original investigator, and giving to both the latter ample opportunity of publishing their theses or researches. It has not even forgotten the specialists, for whom it has collected vast stores—stores in every way available, as most of the specialists in Europe will gladly testify.

Very truly writes Prof. A. Agassiz in reference to original investigation, that such is always best promoted in connection with educational institutions, and we would that the fact were more recognised in these countries; and in regard to museums belonging to such he suggests that they should grow so fast, and no faster, as the demand for such growth arises, otherwise they become mere unwieldy and meaningless accumulations. We may add that in countries where large museums are kept up by the State, University or College Museums on an extensive scale are a vast mistake. The college student's needs are very limited, and the money spent on adding to and keeping up collections would be infinitely better expended as aid to original research. All experienced teachers know how small is the stock of material required for their demonstrations, and how comparatively easy nowadays it is to procure such.

Prof. Agassiz hints that it would be desirable if, in connection with the Laboratory of the United States Fish Commission, the Universities of the United States should found a sea-side laboratory, which would render unnecessary, unless for special work, the various establishments already being established along the American coast. The hint should not be lost on our own Universities and Colleges, which should be urged to assist in the establishment of the British Biological Station. A long list of donations and purchases, an account of the work done, memoirs published or assisted by the loan of collections, conclude this very interesting Report.

TECHNICAL EDUCATION IN NEW SOUTH WALES

THE progress of technical education during the last few years in this country has been watched with great interest by some of our more important colonies which are desirous of not lagging too far behind the mother country in their arrangements for giving special instruction to artisans in subjects allied to the industries in which they are engaged. The Report of the Minister of Public Instruction of New South Wales recently issued contains some interesting particulars as to the establishment of a Technical College in Sydney and the organisation of trade classes in the colony. The present

Technical College of Sydney, like many similar institutions in this country, has grown up out of the Sydney School of Arts. From 1873 to 1877 plans for the extension of the school were carefully considered, and in 1878 the Colonial Parliament granted 2000*l.* towards the inauguration of a Technical College. In 1883 the Government decided to establish a State system of technical education in New South Wales, and having carefully examined the scheme of the City and Guilds of London Institute, and compared it with what was being done on the continent of Europe, they decided that the course of study and system of instruction to be adopted in their college should "accord with the practice of the City and Guilds of London Institute, with such modifications as seemed necessary to meet local requirements and appliances." "Following out the principle laid down by the City of London Guilds for their own guidance, the Board of Technical Education resolved that the object of technical instruction in the colony would be to improve the industrial knowledge of workmen by teaching the sciences and principles underlying their handicraft, and that such teaching should be illustrated by the best apparatus and machines that can be obtained, and by visits to workshops, manufactories, &c." No sounder views than these could be expressed. In 1884 the Parliamentary vote for technical education had increased to 17,093*l.* 3*s.* 4*d.*, and more than forty classes were in operation at the College. These figures indicate the great advance that has been made. As now organised, the College contains thirteen departments, viz., Agriculture, Applied Mechanics, Art, Architecture, Geology, Chemistry, Commercial Economy, Mathematics, Music, Elocution, Pharmacy, Physics, and Domestic Economy. Some of these subjects are outside the curriculum of our own Technical Colleges; but there is much to be said in favour of the introduction of some non-scientific subjects into a technical course; and where statesmanship is almost a profession the study of elocution in early youth is of distinct advantage. The average number of students in the College during the past session has been 917, and the fees paid by the students amounted to 1838*l.*

For the benefit of artisans engaged in the building-trades, classes have been established in decoration, plumbing, bricklaying, wood-carving, carpentry, and joinery; and in many of those classes the syllabus of instruction is identical with that in use at the Finsbury Technical College. Recently, the Council of the City Guilds Institute have received an application to extend their technological examinations to the colony, and to award certificates and prizes on the results. This application is at present under the consideration of a Committee of the Institute. There can be no doubt that all efforts to bring the colonies and mother country into closer relationship should be encouraged, and the more the colonial system of education is assimilated to our own, the greater will be the sympathy between the colonists and the inhabitants of the United Kingdom. This sympathy is of greater advantage to our commercial interests than is generally supposed; for it tends to link together the colonies and the mother country into one vast empire, the several parts of which will depend upon one another rather than upon foreign markets for the supply of their various wants.

It is to be hoped that the example of New South Wales will be followed by Victoria, and may extend to New Zealand and to other parts of our colonial empire. The advancement of technical education in our colonies is to us a matter only second in importance to the improvement of the means of technical instruction in our own manufacturing towns; and it must be a source of satisfaction to the City and Guilds of London Institute that the influence of its operations is being felt, not only in the centres of our home industries, but already in one of the most flourishing of our colonies.

SEEBOHM'S HISTORY OF BRITISH BIRDS[1]

SINCE our last notice of Mr. Seebohm's book (NATURE, vol. xxviii. p. 126) the author has brought it to a successful conclusion, and has fully sustained his reputation as an original and painstaking writer. The great defect in our standard works on British birds has been a want of originality, as one author after another, and one editor after another, have compiled books on the subject, each one founded on the labours of their predecessors, so that the best books have been but compilations. Mr. Seebohm has started on quite a different principle, and the greatest charm of his book consists in the account of the life and habits of the birds, drawn from his own actual experience of the species in their native haunts. And before giving to the world his varied experiences, he has, as is well known, travelled extensively in Europe and Northern Asia, and has become celebrated as the discoverer of the breeding-places of many species of European birds, previously unknown. In this respect he resembles the late John Wolley, for whom a fellow-feeling of sympathy is expressed by Mr. Seebohm throughout his work, but, more fortunate than that well-known naturalist, our author has survived to record in his own books the results of his successful expeditions. It must not, however, be supposed that Mr. Seebohm, in giving us detailed accounts of the life of the birds, has neglected in any way the scientific portion of his task. On the contrary, he has grappled with this difficult subject in a manner which is highly creditable, and however divided opinions may be as to the advisability of some of the changes of nomenclature which he introduces, there can be no question as to the greater simplicity which he has once more attached to the names of the British birds, and we believe that he will be largely followed. Some revision of the code of rules proposed by the British Association appears to us to be necessary, and we trust that ere long Mr. Seebohm or some other ornithologist will draw out a scheme for their modification, in order to bring them into harmony with the more advanced state of science of the present day; and an attempt to arrive at a definite understanding with our Continental and American brethren as to the employment of a uniform system of nomenclature ought soon to be made. The opportunity may probably come when the authoritative "List of North American Birds" is promulgated by the American Ornithologists' Union, a work which is anxiously awaited by naturalists in this country, and it will then be competent for us to consider the merits and demerits of the trinomial system of nomenclature which is gaining ground considerably on this side of the water, but which cannot be adopted without the utmost consideration. Mr. Seebohm does not hesitate to adopt it, but how far he will be followed remains to be seen.

We can cordially recommend this book to all lovers of ornithology, both at home and abroad, and to young and old alike, for they will find ample material for study, and a very great deal that is new. It is by far the best introduction to a knowledge of British birds that we are acquainted with, and a great deal of the subject-matter is very original. The criticisms of contemporary ornithologists are occasionally somewhat hard, but no one can complain of a want of candour on the author's part, and as he no doubt expects equally hard hitting in return, he must have counted the cost before striking at the authors who so often arouse his ire. One thing we do not clearly understand, and that is the constant odium thrown by Mr. Seebohm upon the "Ibis List of British Birds" compiled by a Committee of the B.O.U., of which the author was himself a member. A long time was spent by this Committee in investigating the subject, and as its conclusions were carried by a majority of votes, all the members

[1] "A History of British Birds; with Coloured Illustrations of their Eggs." By Henry Seebohm. Vols. I. to VI. (London: R. H. Porter, 1883 to 1885.)

of the Committee ought to acquiesce in its decisions. We ourselves do not agree with every point of the Committee's work, but at the same time the "List" supplied a great want in ornithology in this country, and it will, no doubt, be greatly improved in a second edition.

Oologists in this country have in Mr. Seebohm's work a thoroughly good hand-book, the figures of the eggs being highly satisfactory, while as to the information concerning the nesting-habits and life of the birds, we believe this "History of British Birds" to be by far the most complete yet published in this country. R. B. S.

NOTES

THE collection of funds for the Pasteur Hospital is proceeding rapidly. The total of the first list is a little under 10,000*l*.

IN reply to a recent letter from the Russian Minister of Education, M. Pasteur has written offering to receive Russian doctors for instruction, and suggesting that Russia should contribute towards the establishment of his proposed Institution at Paris. A small establishment for the application of M. Pasteur's method against rabies has already been started in St. Petersburg, on the initiative and at the expense of Prince Alexander of Oldenburg, where experiments on rabbits and dogs are now being made, preparatory to the treating of persons in danger of hydrophobia.

IN the House of Commons, last week, in reply to a question by Sir Henry Roscoe, Mr. Chamberlain stated that his attenhad been called to the reported discovery by M. Pasteur of a cure for hydrophobia. The recognised eminence of M. Pasteur as a scientific investigator, and the great interest and importance which attach to the subject of his recent inquiries, seemed to him to justify a careful and impartial examination of the results obobtained. At present the information on the matter in the possession of his department was too vague and incomplete to afford materials for a full appreciation of M. Pasteur's process. Mr. Chamberlain promised to consider how such an inquiry can be most satisfactorily conducted, and to confer with the Chancellor of the Exchequer with reference to the question of the expense. He hoped to be able to arrange for such an investigation as may enable a just estimate to be formed as to the reliability of M. Pasteur's method and its applicability to this country.

THE French Minister of Public Instruction has applied to the French Parliament for a grant of about 150,000 fr. for the building of an equatorial-coudé according to the Lœwy system. The total sum required will be 100,000 fr. more.

AT the last meeting of the Berlin Anthropological Society Prof. Virchow stated that the German Colonial Society had sent circulars to all European colonies situated in the tropics requesting observations to be made regarding the question of the acclimatisation of Europeans in the tropics, the result of this inquiry to be communicated to the German Naturalists' Association at their next annual meeting in September. An exhibition of objects required in fitting out scientific travellers for their journeys will also be held at the same time as the meeting of German naturalists.

THE Ben Nevis Weather Reports chronicle an extraordinary dryness of the air in the end of last week. From 3 a.m. of Thursday the air became so dry that a humidity of about 15 per cent. was maintained for some time, and the dew-point fell to $-24^{\circ}\cdot0$. On Friday the humidity was about 13 per cent. till 3 p.m., when the air became still drier, and at 9 p.m. the humidity was only 8 per cent., the readings at this hour being: dry bulb, $19^{\circ}\cdot2$, and wet bulb, $13^{\circ}\cdot0$. The great dryness ceased at midnight, when the air suddenly became saturated. The snow lying at the Observatory at present is not much more than half the quantity of the two previous winters at this season.

IT is reported that on Sunday night, about 11 o'clock, a sharp shock of earthquake, lasting seven seconds, caused a panic at the theatre in Granada. The audience rose, and rushed into the streets. The inhabitants, awakened by the shock, poured out of their houses, and many persons remained in the streets and squares part of the night. Very little material damage was done to the houses, and none to the public buildings, for the preservation of which the authorities have adopted precautions. The shocks were oscillatory from west to east, and accompanied by a rumbling noise. The shock was felt also in the districts which were the scene of the earthquake of 1884. The villagers were terribly alarmed, and some houses were injured.

A VIOLENT shock of earthquake was felt at Wiesbaden at twenty-eight minutes past midnight on Sunday.

THE fourth volume of Dr. M. C. Cooke's "Illustrations of British Fungi" is just completed, bringing the total number of coloured plates up to 622, illustrating 790 species and varieties of *Agaricus*, or more than double the number figured by Fries in his "Icones," and nearly as many as there are in the combined works of Sowerby, Hussey, Bolton, Bulliard, and Krombholz. It is estimated that the two volumes yet to be published, if the author receives sufficient support, will contain about 400 additional species, making a total of nearly 1200 species and varieties of the gill-bearing *Fungi*, or nearly three times as many as in any other work in existence. The four volumes accomplished represent five years' laborious work and a great expenditure of money by the author, who is publishing at his own sole cost; yet we are assured that he has not only derived no profit therefrom, but has suffered a loss, and this in spite of his having saved the expense of an artist. Surely there must be a sufficient number of persons in this country interested in botany to render such a work self-supporting, if not remunerative; especially as the price is about half that of contemporaneous Continental works on the same subject. Dr. Cooke, in response to numerous solicitations, also proposes issuing a volume of coloured plates of British Desmids as a supplement to his "British Fresh-Water Algæ," provided a sufficient number of subscribers come forward.

NEAR the village of Dorndorf (Prussian province of Nassau) considerable alarm has recently been caused by the repeated appearance of extensive fissures in the surface of a hill. Quite lately the main fissure has advanced to within 100 metres of the village, at which point it, however, turned aside, seemingly returning to its starting-point. Subsidence of the soil has also been noticed in several parts of the circumscribed area, which measures about a mile in diameter.

THE climate of Lucerne has been described by Herr Suidter (in a recent address there) on the basis of five years' observations at Mariahilf. Lucerne, he says, is in the föhn-climate, but on the outer edge of its zone (the föhn being, it is known, a strong, warm, descending wind of southerly direction in Switzerland). The former is proved by the preponderance of warm winds and the large rainfall (average 1275·8 mm. in 1879-83) compared with Central Switzerland, the latter by the low mean annual temperature ($8^{\circ}\cdot284$ C.), and by a much less rainfall than places near the source of the föhn, such as (in descending order) Rigikulm, Vitznau, Schwyz, and Engelberg; where the föhn blows much oftener and more continuously and strongly. A peculiar green tinge of the sky's blue over the Uri or Obwaldner Mountains tells the Lucerners of the föhn's coming, some 12 to 24 hours in advance. Drenching rain nearly always comes with it. The lowest temperature in those five years was -17° C. (in 1879); but years often pass without the thermometer going down to $-10°$ or $-15°$. In the cold winter of 1879 the arm of the lake never became unnavigable from ice, and the robust exotic plants in the open gardens were scarcely damaged at all. The vegetation of Lucerne is much more southerly than the mean annual temperature of $8°·284$ would lead one to expect. It is an interesting fact that as early as 1598 there was in Lucerne a small botanic garden (formed by Renward Cysat), where many exotic plants, such as tobacco, were grown, and from which issued the best methods for cultivating fruit-trees, &c.

THE curious phenomenon of "lake-balls" is to be met with on the Sils Lake and others in the Upper Engadine. They are composed of larch-leaves felted together. Three samples (the largest over a foot in diameter) were recently exhibited by Herr Coaz at the Berne Naturalists' Society, and he stated that these balls are formed in small bays into which the prevailing southwest winds blow. The water acquires a whirling motion, and the larch-leaves involved in it, together with pieces of moss, &c., are worked into balls. There is no cementing with mud. Sometimes, on shallow banks—not in bays—sausage-like forms are met with. Prof. Fischer made reference to another kind of lake-balls formed of a filamentous alga in the lakes of Sweden and other countries; also to the marine balls, formed of fragments of phanerogamic sea-plants (Zostera, Cymodocea, &c.) which were at one time used medicinally.

AT the last meeting of the Seismological Society of Tokio, Prof. Milne read a paper describing the results obtained from a seismic survey of the ground in the neighbourhood of his house. By the seismic survey of a district he meant an examination of the different parts of that district with regard to the effects which were produced upon them by earthquakes. After describing local peculiarities of the ground, he said that he placed at different places, but in similar positions, similarly constructed seismographs. These had been proved to give diagrams which were practically absolute measures of the movements of the ground, and, when any of these instruments were placed side by side, they gave similar results. The result of observing many earthquakes was that all the instruments, the positions of which would be included in a triangle the sides of which were 800 or 900 feet in length, gave different indications as to direction, amplitude, maximum velocity, and intensity. So that, had these instruments been in the hands of different observers, each observer would have given a different account of the same earthquake. Thus, comparing the average maximum velocities at a station, C, on hard ground, with that at a station, E, on soft ground, they were found to be 1 : 5. The maximum accelerations at these two stations were 1 : 2·4. It might therefore be concluded that a building at C would withstand a disturbance which would be sufficient to shatter a similar building placed at E. Prof. Milne also described further experiments made with a seismograph placed in a pit 10 feet deep, and with a wooden building the foundations of which at first rested on 10-inch cannon-balls, and subsequently on cast-iron shot 6 mm. in diameter.

ALL these experiments were made with a view to discover the best method of constructing buildings which would stand earthquake shocks with least damage. The practical conclusion of the investigation was that there were three ways by which residents could escape from very much of the motion which disturbs an ordinary building. These were (1) by a seismic survey they might select a site where there was relatively little motion; (2) they might build up from the bottom of a pit, which might be utilised as a cellar, the walls of the houses not touching the sides of the pit; (3) when obliged to build on soft ground, when a pit could not be excavated, a light one-storied building of wood or iron might be rested on a layer of cast-iron shot.

WE have received from Dr. D. J. Macgowan, whose name has for many years been well known to all students of China, a copy of a curious paper by him on the movement cure in China, contributed to the *Medical Reports* of the Chinese Customs. In form the paper (which contains several interesting illustrations of the *modus operandi* of the cure) is a notice of successive writers on the system of therapeutics, which was actually practised on the late Empress by a high official who was supposed to be an adept in the art. The notion that supernatural power was imparted to the human frame, and that the latter was rendered invulnerable to disease and death, by breath-swallowing, or accumulations of air in the system, is a very old one. About the sixth century before our era a celebrated writer recommended a mild form of exercise to effect this, and this exercise, with breath-gulping, now constitutes the Chinese movement cure. After tracing the fluctuations of the practice and their causes, Dr. Macgowan comes to a work published in 1858 by the high official already mentioned. Life, it is taught, depends on the existence of a primary aura; so long as a particle of it is retained in the system, death cannot occur. A deficient supply is the cause of disease; and when it duly permeates the system, every ailment is averted. The object of the postures, motions, and frictions is to promote the due circulation of that vital air. One writer illustrates the state of the system that is thoroughly saturated with air by that of a drunken man who falls from a cart without sustaining injury, because of intoxication; so a man permeated with the vital aura is invulnerable. Disease appears only when the vitiated air can find entrance, when the circulation of the vital air is defective. The air starts in its circulatory movement from the "little heart," which is situated in the pubic region; air-vessels convey it thence upward anteriorly to the forehead, where these vessels become continuous with a similar system that returns the air posteriorly to the "little heart." Without fire this aura is the source of animal heat; without water it lubricates the viscera. Fate, indeed, determines longevity as it does birth, yet disease may be averted by employing the movement cure, which is preferable to delaying until disease sets in, when the art is comparatively useless. These are the principles on which the cure rests.

THESE curious searchings into the mysteries of life and death are followed by a description of the details of the process. These are too numerous and complicated to be mentioned at length. They deal with the periods of air-swallowing and friction, the time for inhaling the sun's air and the moon's air, the time and modes of friction, the implements for shampooing (amongst them being a bag filled with water-worn pebbles, and a pestle or round bat for pounding the abdomen), and the various muscular movements, many of which are exceedingly comical. In gulping air the east should be faced, and twelve of the various operations described should be gone through each forty-nine times. In going through the exercises there is to be no thinking, for the mind must be absolutely quiescent. Reference to this air-swallowing is made in the earliest extant Chinese medical treatises, but regular practitioners have always regarded the exercises as charlatanism.

MR. HOWARD GRUBB, F.R.S., will give the first of two lectures on the Astronomical Telescope on Saturday (March 27), at the Royal Institution; and on Friday (April 2) he will give a discourse on Telescopic Objectives and Mirrors: their Preparation and Testing.

M. GASTON TISSANDIER has issued the prospectus of a large work which he is preparing on the great aëronauts. The work will be in two volumes, the first of which is to appear next October.

The additions to the Zoological Society's Gardens during the past week include a Silky Marmoset (*Midas rosalia*) from Brazil, presented by Mr. Percy Bewick Bewick; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mrs. Dunn; a White-crowned Mangabey (*Cercocebus æthiops*) from West Africa, presented by Mr. N. King; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. W. A. Rooff; a Black-backed Jackal (*Canis mesomelas* ♀) from South Africa, presented by Mrs. E. Thomas; a Grey Ichneumon (*Herpestes griseus* ♀) from India, a Demoiselle Crane (*Grus virgo*) from North Africa, presented by Mr. T. W. Proger; a Moor Monkey (*Semnopithecus maurus* ♀) from Java, deposited; a Talapoin Monkey (*Cercopithecus talapoin* ♀) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN

Dark Transits of Jupiter's Fourth Satellite.—Prof. Davidson, of the U.S. Coast Survey, has communicated to the Californian Academy of Sciences some interesting notes of observations of "dark" transits of Jupiter's satellite IV. made by Mr. Burckhalter with a 10½-inch reflector. Mr. Burckhalter's observations on May 21, 1885, suggest the possibility that the satellite has an area of white surface and also an area of dark surface. When the satellite approached the planet it appeared bright, the white area being then the visible part; but when it had advanced some way on the disk, this white part was (on this supposition) lost in the superior brightness of the planet, and the dark area became visible. Prof. Davidson thinks it might even lead to the determination of the rotation period of the satellite if it were watched throughout the whole transit, and the different phases noted. Again, observing on June 7, 1885, Mr. Burckhalter saw the satellite as a dark spot on the edge of the north dark belt. But as soon as the satellite was clear of the planet's disk, it was noted to be north of this belt; so that it would appear from this observation also as if the satellite were divided into bright and dark areas, the south pole being the dark one. Prof. Davidson also observed the transit of June 7 with a 6·4-inch refractor, and confirms generally the appearances noted by Mr. Burckhalter.

Nova Andromedæ of 1885, and Nova Scorpii of 1860.—With reference to Prof. Seeliger's researches on the subject of the Nova in Andromeda (Nature, vol. xxxiii. p. 397), Herr Auwers draws attention in the *Astronomische Nachrichten*, No. 2715, to the great similarity of this outburst to the phenomenon observed by him in 1860 in the nebula 80 Messier in Scorpio. He considers that the probability that, in an interval of twenty-five years, two variable stars of so exceptional a character should be projected on the central part, in one case of a close star-cluster, in the other case of an object which appears to be, in part at least, a close star-cluster, is so small that the identity of the circumstances attending the phenomena of 1860 and 1885 makes it almost necessary to refer both outbursts to physical changes in the nebulæ in which they respectively appeared. As Prof. Seeliger makes no mention of this (in Herr Auwers' opinion) very strong argument in favour of his supposition respecting the cause of the outburst in Andromeda, Herr Auwers is induced to do so, and takes the opportunity of publishing the details of his observations of the Nova of 1860, an account of the discovery of which was printed in the *Astronomische Nachrichten*, No. 1267. Herr Auwers states that having turned the Königsberg heliometer on 80 Messier on the evening of May 21, 1860, he saw a 7th magnitude star in the nebula, a little following the central part, which it quite outshone in brilliancy. By June 16 this star had degraded to magnitude 10·5. It will be remembered that the "new" star in Scorpio was independently discovered in this country by Mr. Pogson, whose attention was arrested on May 28, 1860, "by the startling appearance of a star of the 7·6 magnitude in the place which the nebula had previously occupied." On June 10, according to this observer, the stellar appearance had nearly vanished, but the cluster still shone with unusual brilliancy and a marked central condensation.

Fabry's Comet.—The following ephemeris, by Dr. H. Oppenheim (*Astr. Nach.* No. 2711) is in continuation of that given in Nature for 1886 March 4:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Brightness
March 23	23 16 58	36 5·6 N.	9·8421	0·0589	20
27	23 16 57	37 12·4	9·8233	0·0203	26
31	23 17 59	38 11·5	9·8102	9·9744	34
April 4	23 20 55	38 58·9	9·8043	9·9198	45
8	23 27 4	39 28·7	9·8062	9·8547	61
12	23 38 33	39 31·4 N.	9·8157	9·7767	83

The brightness on December 2 is taken as unity.

Barnard's Comet.—The following ephemeris, by Dr. A. Krueger (*Astr. Nach.* No. 2710), is in continuation of that given in Nature for 1886 March 4:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Brightness
March 22	1 51 49	27 34·3 N.	0·0217	0·2230	7·12
26	1 51 13	28 57·0	9·9917	0·2144	8·51
30	1 50 34	30 23·2 N.	9·9594	0·2036	10·38

The brightness on December 5 is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 MARCH 21-27

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

At Greenwich on March 21

Sun rises, 6h. 1m.; souths, 12h. 7m. 15·4s.; sets, 18h. 13m.; decl. on meridian, 0° 19′ N.: Sidereal Time at Sunset, 6h. 10m.

Moon (one day after Full) rises, 18h. 50m.*; souths, 0h. 53m.; sets, 6h. 45m.; decl. on meridian, 2° 35′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 19	13 12	20 5	9 40 N.
Venus	4 23	9 43	15 3	8 37 S.
Mars	15 54	22 55	5 56*	11 11 N.
Jupiter	18 4*	0 13	6 22	0 59 N.
Saturn	9 59	18 11	2 23*	22 48 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
23	γ Libræ	4½	23 19	23 58	93 167
24	η Libræ	6	4 18	5 34	75 285

March	h.	
21	19	Jupiter in opposition to the Sun.
22	2	Mercury at greatest elongation from the Sun, 19° east.
25	—	Venus at greatest morning brilliancy.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Mar. 23,	19 35	*m*
Algol	3 0·8	40 31 N.	,, 21,	1 7	*m*
			,, 23,	21 56	*m*
R Aurigæ	5 8·1	53 27 N.	,, 22,		*m*
ζ Geminorum	6 57·4	20 44 N.	,, 25,	4 50	*M*
U Monocerotis	7 25·4	9 32 S.	,, 21,		*M*
δ Libræ	14 54·9	8 4 S.	,, 25,	21 18	*m*
T Libræ	15 4·2	19 35 S.	,, 24,		*M*
U Coronæ	15 13·6	32 4 N.	,, 23,	2 29	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 24,	4 40	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	Mar. 24,	0 0	*m*
			,, 26,	21 30	*M*
W Sagittarii	17 57·8	29 35 S.	,, 22,	2 20	*M*
T Herculis	18 4·8	31 0 N.	,, 24,		*M*
β Lyræ	18 45·9	33 14 N.	,, 22,	2 20	*M*
R Cygni	19 33·8	49 57 N.	,, 22,		*M*
η Aquilæ	19 46·7	0 7 N.	,, 25,	0 0	*M*
δ Cephei	22 24·9	57 50 N.	,, 22,	19 10	*m*

M signifies maximum; *m* minimum.

BIOLOGICAL NOTES

The Pelagic Stages of Young Fishes.—The memoirs by Alex. Agassiz, on the young stages of osseous fishes, have been noticed from time to time in our pages. In connection with C. O. Whitman, he has quite recently published, as the first part of vol. xiv. of the *Memoirs* of the Museum of Comparative Zoology at Harvard College, an account of the pelagic stages of young fishes, which is illustrated with nineteen very beautifully-executed plates. This memoir is devoted to descriptive sketches of the different fish-eggs which have come beneath the notice of the authors, and of the early stages of the fish after their escape from the egg. In a second portion of the memoir it is proposed to treat of the earlier stages of cleavage, the formation of the embryonic ring, the formation of the various portions of the embryo, and so on. The pelagic eggs, so far as the authors' experience goes, may be divided into—(1) those without oil-globules, and (2) those with one or more oil-globules. But this, while a convenient, is not an accurate division, because, if eggs apparently without oil-globules are carefully examined, the yolk-mass will be found permeated with minute fatty bodies, but these are never seen to coalesce to form conspicuous oil-globules. Some pelagic eggs are laid singly—this seems to be the most common condition—and are left to float at the mercy of the waves and winds, while others are laid in an investing gelatinous mass. The single eggs seem to have the best chance of escape from their numerous enemies, while as to those laid in masses the chances seem all against them. When first laid, pelagic eggs are usually perfectly transparent; little by little, with the formation of the embryo, chromatophores are formed, generally upon the surface of the yolk-mass close to the embryo, or upon the embryo itself. These chromatophores, at first colourless, soon become pigmented, and while the young embryo is still within the egg, the characteristic colour-pattern is often clearly indicated. All the eggs described in the memoir, except when confined in masses, float with the embryo downwards. The resorption of the yolk-mass differs greatly in the different species. The rate of resorption also varies, and would seem to be correlated with the degree of development of the structural features of the embryo. The chromotaphores very rarely become dendritic before the embryo is hatched, and as a rule not till then does the black eye-pigment make its appearance. The first fins formed are the pectorals, traces of which appear in very early stages within the egg. The closing of the blastopore and the disappearance of the vesicle of Kupffer are followed by the growth of the tail and the formation of an embryonic caudal fin. Usually at the time of the resorption of the yolk-mass the pectorals are well developed, and have become powerful limbs; then, too, the intestinal tract lengthens, and a swim-bladder and larger alimentary canal appear. In the very youngest stages, immediately on leaving the egg, the embryo depends mainly upon its embryonic dorsal and ventral (its leptocardial fin) fin for locomotion. The propelling powers are proportionally very large, and at no time of its life is the young fish better provided with both means of locomotion and sense-organs. With growth the young fish depends, however, more and more for locomotion upon the use of its pectoral fins. The comparatively large size of the chorda in the earlier embryonic stages is a marked feature of all young fishes. The regularity with which the same stages of development of identical species appeared in successive years was very striking, and the authors note that this regularity was not peculiar to young fishes, but that they also found the spawning of the majority of marine animals and their rate of development practically identical year after year; as instances of the latter they refer to embryos of Agalma, Balanoglossus, Plagusia, &c. To facilitate the identification of the different pelagic stages of fish and fish-eggs, a table is given, in which we find the most characteristic features of the eggs and young fish so far as these have been observed, the date of their occurrence, the distinctive features at time of hatching, with references, so far as the forms described in this memoir are concerned, to its pages and its figures, and for the rest to authorities where they have been described. The figures on the plates are from sketches from life made by A. Agassiz and Whitman. We trust soon to be able to notice the second portion of this important memoir.

Danais archippus—an Enterprising Butterfly.—As an instance of a species extending its geographical area under our observation, perhaps there is none more remarkable than the case of a beautiful and noteworthy butterfly whose natural history is so pleasantly written about in the *Entomologist's Monthly Magazine* for March 1886 by Mr. James J. Walker, R.N. We would that our British Navy had many more such excellent observers. This butterfly, which, according to the rules of zoological nomenclature, is called *Anosia plexippus*, L., is perhaps better known by its synonym, *Danais archippus*, F. The original home of this insect is the American continent, where, including some well-marked varieties, it now enjoys a vast range, extending from the Hudson's Bay Territory and Canada to the region of the Amazons, Bolivia, and the estuary of the Rio de la Plata. Nearly everywhere through this vast area it is common, and in some places it occurs in vast swarms. Thus Mr. Riley says that at Missouri the air is sometimes filled with these butterflies to a height of from 300 to 400 feet. These swarms appear in autumn, and some of them seem to migrate southwards to warmer regions at the approach of winter. The caterpillar is singularly hardy, handsome, and easy to rear; it feeds on various species of Asclepias, a genus belonging to one of the most interesting families of plants known. All the species of the genus are peculiar to the New World—and to the northern portions of it, just that area which seems to have been the birth-area of our butterfly—or to tropical Africa. Many of them are hardy even in this country, and are easily increased, taking care, as a gardener would say, of themselves. *A. tuberosa* is a fine border plant; *A. cornuti* has sweet-scented flowers; while *A. curassavica*, though bearing showy flowers, has a fœtid perfume, like its congeners, the Stapelias, those African Asclepiads so attractive to the carrion-flies; this last species is the one so fully described by H. Müller as fertilised through the agency of Lepidoptera. The chrysalis of *D. archippus* is described as very beautiful, being of a bright, translucent, emerald-green colour, with some transverse black ridges, brilliantly-gilded lines, and minute spots of a bright gold hue, and the duration of the pupal condition is from fourteen to twenty days. Insect-eating birds do not touch either larval or perfect forms, which are free even from Ichneumon guests. It is interesting to note that Mr. Riley has found the larva attacked by a Dipteron, this group of insects being intimately connected with the life-history of Asclepiads. The longevity of the imago is most remarkable. Taking all these facts into consideration, we find this butterfly well outfitted for the battle of life: the perfect insect strong on the wing, with from twelve to fifteen months of a life; eggs soon hatching, after being laid on the food-plants, these themselves spreading like weeds; larvæ not molested by destructive parasites. The first great march westwards was over 2350 miles to the Sandwich Islands, and remembering that the appearance of the insect here is subsequent to commerce with these islands, the probability is that it was helped across this expanse of ocean, and then it in a wonderfully steady and rapid manner spread across the whole breadth of the Pacific Ocean, and far into the Malay Archipelago. Carrying on its course round the world, we may soon expect to hear of it in Asia. Southwards and westwards it has appeared in New Zealand and Australia. After enterprise like this, it does not seem surprising that eastward it should have flown to the West Indies, and at least one or two examples to the Azores; and within the last ten years it has put in an appearance and been speedily captured in South Wales, Devon, Isle of Wight, Dorset, Sussex, and Kent. In 1879 a specimen was even taken at La Vendée. While as garden plants species of Asclepias are fairly common in Britain, in Europe other food-plants might be found in *Vincetoxicum officinale* and *Cynanchum acutum*. With such a startling phenomenon in distribution, which in so gay and fine an insect cannot easily be overlooked, a great light is thrown on the diffusion under perhaps even more favourable circumstances as to the distribution of less conspicuous species. We should have welcomed some remarks from Mr. Walker's pen about the varieties that may have arisen from the very varied surroundings that environ the butterfly; one of these, *D. erippus*, seems by some entomologists almost to take rank as an independent species; that is to say, that it has passed too far away from the type to be easily recognised as such.

GEOGRAPHICAL NOTES

The following medals have been awarded by the Geographical Society of Paris for 1886:—The principal gold medal to MM. Capello and Ivens for their three journeys across Africa; gold medal to the Pandit (name not specified, but doubtless A——K) for his journey in Tibet; the Lagerot prize to M. Morsche for his explorations in the Philippines; a silver medal to M. Bloyet for his topography of Eastern Africa; and the bronze medal to M. Mager for his *Atlas Colonial*, published by M. Bayle.

ETHNOLOGISTS will be glad to know that the February number of the *Bolletino* of the Italian Geographical Society contains a full descriptive account of the objects forwarded to Europe by Romolo Gessi after his return to East Central Africa in 1877. These objects have now been added to the rich collection which he had already presented to the Geographical Society, and which has found a permanent home in the Prehistoric and Ethnographic Museum in Rome. Amongst the objects specified by Dr. G. A. Colini, to whom the public is indebted for this paper, mention is made of a stool from the Bongo tribe (Upper White Nile) with feet made exactly like the boots usually worn by European ladies. This object was locally known as "the lady," and it is suggested that the native artist took for his model the boots belonging to Miss Tinné. The artistic talent of the Bongos is, however, better illustrated by the figure of a man 0·69 metres high, wearing a girdle of cylindrical glass trinkets, and with upper lip and ears pierced for the insertion of the iron rings commonly worn by this tribe. From the Latuka people on the opposite or east side of the Nile come ivory trumpets, wooden clubs with iron heads, curious knives with slightly curved blade and wooden handle inlaid with iron plaques, and a very fine helmet decorated with shells, red and blue glass beads and a triangular brass plate in front. The A-Zandeh (Niam-Niam) and Mangbuttu (Monbuttu) objects are distinguished by their number, variety, and richness, including articles in wood, iron, and ivory: arms, ornaments, utensils, and musical instruments. The ivory carvings often display great taste in the designs and technical skill in the execution, fully bearing out the accounts of Schweinfurth and other travellers regarding the great artistic talent of these cannibal tribes. Archæologists will be interested to know that amongst the Mangbuttu objects is a splendid polished stone hatchet 0·25 metres long, with circular section, and terminating above in a point, which must be classed with the prehistoric hematite weapons supposed by the natives to have fallen from the clouds. Nearly all the tribes of the Upper Nile Valley, and even several of the equatorial lake region, such as the Waganda and Wanyoro, are represented in this very valuable ethnological collection, probably the most complete yet brought together from that quarter of the globe.

AT the meeting of the Paris Geographical Society of the 19th ult. Vicomte de Brettes described the results of an exploration made by him during last year in the southern Grand Chaco. Since the commencement of the sixteenth century forty-three expeditions have attempted to discover a communication between the regions on the eastern slope of the Andes with those on the left banks of the rivers Paraguay and Parana. These expeditions have constantly followed the courses of the Pilcomayo and Vermejo, and have ultimately demonstrated the impracticability of these routes by reason of the numerous rapids, as well as of the shallowness of the water. The route so actively sought for three centuries by the Argentine Republic, Bolivia, and Paraguay, which would increase their trade tenfold, has never yet been sought by land, and since the Spanish conquest the interior of the southern Grand Chaco has remained wholly unknown. M. de Brettes undertook this exploration, and entered the region accompanied only by two Chenupis Indians. He discovered three rivers and an immense salt lake, on the banks of which he marched 113 miles, when ague and fever compelled him to return to Corrientes after a journey of 436 miles in a hitherto-unexplored region. The country traversed by him is absolutely flat, mimosa-trees and palms grow in abundance, and there are vast prairies and swamps, inhabited by the Chenupis, Mocovis, Velelos, and Matacos—all tribes still in an extremely barbarous state. The lecturer referred to various unpublished documents respecting these tribes, including a grammar of the Topii language, which is in the press. He also announced his intention of returning to the Chaco to continue the work which was arrested by illness. He appears to have received the most cordial assistance from the Argentine authorities.

ON February 12 General Prjevalsky gave a lecture on his fourth journey to Central Asia before a distinguished audience at St. Petersburg. He entered into details on the sources of the Yellow River, and described the environs of Lob-nor, dwelling upon the peculiar features of the population of the surrounding country. Then the lecturer passed to the orographic outlines of the Alpine country, the numerous chains of which had been first traced by himself, and finally concluded his account by describing the valley of the River Tarim. The lecture was very well illustrated.

THE March number of the *Proceedings* of the Royal Geographical Society has for its leading paper an account, by Col. Stewart, of the Herat Valley and the Persian border, from the Hari-rud to Sistan. It contains a large amount of interesting information respecting a region which appears destined to play a larger part in the public eye of England in the future than even in the past. The discussion which followed adds much to the paper, and this is especially the case with the remarks of Surgeon Aitchison, the naturalist to the Afghan Delimitation Commission, who read an account of the botany of the region. Major Greely's lecture on Arctic exploration with reference to Grinnell Land is also published. The number also contains summaries of two lectures, and the subsequent discussions, at the Exhibition of Appliances used in Geographical Education, the lecturers being Profs. Bryce and Moseley.

THE March number of the *Scottish Geographical Magazine* commences with a paper by Col. Stewart on a visit to Badghis in 1883, and to the Herat Valley in 1885. It also contains a paper by Prof. James Geikie on mountains—their origin, growth, and decay; and a brief account of Dr. Boas's recent journeys in Baffin Land. The geographical notes are very comprehensive; amongst them is one, taken from the *Geographischer Jahrbuch*, 1885, containing statistics of the geographical societies of the world. It is somewhat humiliating to find Great Britain and her colonies only third on the list in point of members, and fifth in the number of societies. France has 26 societies with 18,000 members; Germany 24, with 9300 members; while the British Empire has 5 societies, with 5300 members. The United States is even worse, for it has only 2 societies, with 1500 members.

AT the last meeting of the Geographical Society of Paris, M. Hansen-Blangsted read a note on the disagreement between geographers as to the highest peaks in Denmark. According to the maps of the general staff at Copenhagen, the highest hills were in the south-west of the department of Aarhus. Himmelberg was long regarded as the principal eminence in Denmark; it is 147 metres in height. But in the forest of Ky, in the south of the commune of the same name, there are several unnamed heights, one of which is 163 metres high. Himmelberg is now only the third in height, and possibly it will have on examination to take even a lower place. Communications were read from Gen. Annenkoff on the Transcaspian Railway and the region it traverses, from M. Thouar on his exploration on the Pilcomayo, and from M. Duveyrier on some Sahara longitudes.

IN the last number of the *Transactions* of the Halle Verein für Erdkunde, Herr von Brandis describes some curious observations which he made during a year's residence in 1861-62 on the slope of the active Java volcano Merapi, which has lately been in eruption. From the crater two perfectly straight white columns of steam (not smoke), of equal thickness above and below, ascended. For some weeks the colour was of an equal degree of whiteness throughout; both were of equal height, and from measurements made this varied from 320 to 450 metres. The upper ends were cut off sharply like the ends of two tapers, and the thickness of one varied from 5 to 15 metres, while the other was only about half this. The distance between the two appeared to be about 20 metres. The colour of the smaller of these pillars appeared to alter occasionally, but the wind did not seem to have any effect in causing them to deflect from the perpendicular. At first the observer thought there must be perpetual calm at this altitude; but this is not so, for others have found that a south-east wind blows constantly there. The effect of a current of air blowing from this direction would have been readily perceptible to Herr von Brandis in the position his residence occupied. This curious phenomenon was observed in 1836 by Junghuhn, of Madgeburg, who ascended the mountain, but the conditions of the summit do not appear to have been sufficiently investigated to enable a positive explanation of it to be made.

IT is stated that M. Rogozinski, who is at present in Cracow, is preparing a dictionary and grammar of the idioms of the Cameroon tribes.

M. ROLLAND has been charged by the French Minister of Public Instruction with a mission to Madagascar, to study its mineralogy, botany, zoology, and anthropology.

THE SUN AND STARS[1]

III.

The Spots

IN the large photographs now secured at Meudon and in India, and smaller ones now received from India, the Mauritius, and Australia, showing the spots as they are photographed there, I am glad to say almost every day now, on a scale of 8 inches to the sun's diameter, we get wonderful records of what a spot really is, and how it changes.

In a normal spot the exterior shade is called the *penumbra.* The inner darker one is called the *umbra,* and very often there is a deeper shade still, which is called the *nucleus.* In some spots there are many umbræ for one penumbra; and very likely, if one had examined them carefully with the telescope at the time, one would have found that each had its interior nucleus. The idea is that we have at the edge of the penumbra, where the penumbra joins the photosphere, the greatest height of the spot; that the penumbra is an incline going down as gradually as you like, but still down, so that the level of the photospheric stuff, whatever it is, at the edge of the umbra, is below what it is at the edge of the penumbra.

In the penumbra the domes seen on the general surface are drawn into elongated shapes, hence we speak of the "thatch" on the penumbra. Visually the part of the penumbra adjoining the umbra seems brighter than that adjoining the photosphere. In photographs this is not so.

Now, if the view that the spots are cavities be correct, and the appearances they put on in travelling over the sun are sufficient to prove it, it will be clear that there ought to be occasions when a spot going over the limb should show as a depression.

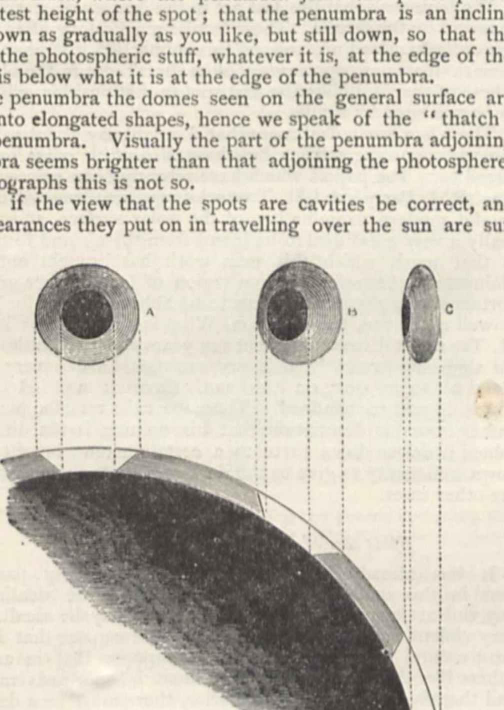


FIG. 4.—Appearances presented by spots. A is the centre of the disk; B between centre and limb; C, near the limb.

The idea that sunspots are cavities is a very old one. It was first put forward by Wilson of Glasgow in the last century; but it was not so easy to demonstrate it to a large audience in the days when one had no photographs.

Here is a photograph showing the retreat of a sunspot over the edge of the sun in 1884. We see that it writes its record in an unmistakable notch at the limb of the sun (Fig. 5).

In other photographs we can conveniently study the connection between the faculæ and the spots, especially if the spots be near the limb; the neighbourhood of spots in this position is very rich in faculæ.

When we come to examine these spots carefully, we find that there are apparently in the main—(I want to speak as guardedly as I can)—two different kinds. Some spots seem to be pretty regular, and to undergo no very violent commotion. I mean that the penumbra and the umbra are not so tremendously contorted and mixed up as sometimes happens; and, again, the ridge of facula round the spot is not so honeycombed by convection-currents and the results of convection-currents. On the other hand, as representing the other class where we get violent action, there seems to be no limit to the enormous energies indicated, and the areas over which these energies hold their sway. I believe that one spot, or at least a spot system, was observed in 1858, of 140,000 miles or eighteen earth-diameters in length. Telescopic examination of each minute part of these enormous disturbances indicates that the most violent changes

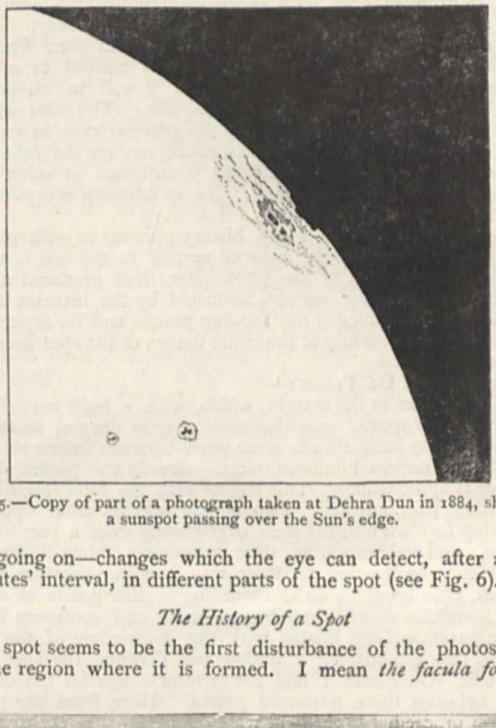


FIG. 5.—Copy of part of a photograph taken at Dehra Dun in 1884, showing a sunspot passing over the Sun's edge.

are going on—changes which the eye can detect, after a few minutes' interval, in different parts of the spot (see Fig. 6).

The History of a Spot

A spot seems to be the first disturbance of the photosphere in the region where it is formed. I mean *the facula follows,*

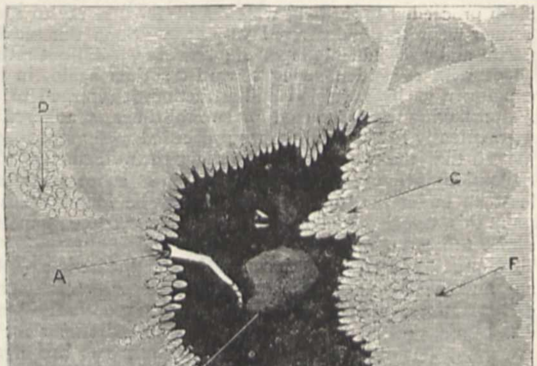


FIG. 6.—Sunspot showing details of the penumbra. The dark portion in the centre is the umbra, the surrounding half-tone is the penumbra. A, a "bridge" or tongue of facula being carried over the umbra; B, clouds forming at the end; C, part of the penumbra being driven over the spot (the domes are drawn out); D, domes on photosphere; F, "thatch" on penumbra.

and does not precede, the spot. On this point I first quote Dr. Peters,[1] one of our highest authorities:—

"The spots arise from insensible points, so that the exact moment of their origin cannot be stated; but they grow very

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 429.

[1] *Proceedings* of the American Association for the Advancement of Science, vol. ix.

rapidly in the beginning, and almost always in less than a day they arrive at their maximum of size. Then they are stationary, I would say in the vigorous epoch of their life, with a well-defined penumbra of regular and rather simple shape. So they sustain themselves for 10, 20, and some even for 50 days."

I next quote the Rev. S. J. Perry, one of the most constant of modern solar observers:—

"And, to begin with spot-formation, we find almost invariably that large solar spots start life as little dots, frequently in groups, and then grow at once with enormous rapidity. A spot will often attain its full size in 5 or 6 days, although exceptionally large ones occasionally occupy a longer time in their first development. If no remarkable increase is noticed in a spot within 2 or 3 days from its birth, it will in all probability never attain to any considerable size. The solar surface has repeatedly been examined with the greatest care, in regions where considerable spots have broken out on the following day, without detecting any marked disturbance or other sign announcing a probable outburst. No satisfactory exceptions to this have as yet been noticed."

The second state of a spot's history presents us with phenomena of reaction, as if the material carried in the first instance below the upper level of the photosphere had produced a disturbance in the lower regions, indicated by the increase in the quantity and brilliancy of the faculous matter and its separation into small masses, while at times the umbra of the spot becomes distinctly coloured.

I again quote Dr. Peters:—

"The notches in the margin, which, with a high magnifying power, always appear somewhat serrate, grow deeper, to such a degree that the penumbra in some parts becomes interrupted by straight and narrow luminous tracts,—already the period of decadence is approaching. This begins with the following highly interesting phenomenon. Two of the notches from opposite sides step forward into the area, over-roofing even a part of the nucleus; and suddenly from their prominent points flashes go out, meeting each other on their way, hanging together for a moment, then breaking off and receding to their points of starting. Soon this electric play begins anew and continues for a few minutes, ending finally with the connection of the two notches, thus establishing a bridge and dividing the spot into two parts. Only once I had the fortune to witness the occurrence between three advanced points. Here from the point A a flash proceeded towards B, which sent forth a ray to meet the former when this had arrived very near. Soon this seemed saturated, and was suddenly repelled; however, it did not retire, but bent with a sudden swing toward C; then again, in the same manner, as by repulsion and attraction, it returned to B; and, after having thus oscillated for several times, A adhered at last permanently to B. The flashes proceeded with great speed, but not so that the eye might not follow them distinctly. By an estimation of time and known dimension of space traversed, at least an under limit of the velocity may be found; thus, I compute this velocity to be not less than 200,000,000 metres [or about 120,000 miles] in a second.

"The process described is accomplished in the higher photosphere, and seems not to affect at all the lower or dark atmosphere. With it a second, or rather a third, period in the spot's life has begun, that of dissolution, which lasts sometimes for 10 or 20 days, during which time the components are again subdivided, while the other parts of the luminous margin, too, are pressing, diminishing, and finally overcasting the whole, thus ending the ephemeral existence of the spot.

"Rather a good chance is required for observing the remarkable phenomenon which introduces the covering process, since it is achieved in a few minutes, and it demands, moreover, a perfectly calm atmosphere, in order not to be confounded with a kind of scintillation which is perceived very often in the spots, especially with fatigued eyes. The observer ought to watch for it under otherwise favourable circumstances when a large and ten- or twenty-days'-old spot begins to show strong indentations on the margin."

The scintillation referred to by Dr. Peters is perhaps associated with a phenomenon which has been described by M. Trouvelot,[1] who has observed the faculous masses to subdivide into small flakes which vibrate rapidly, producing the effect of a snow-storm above the umbra, when these dissolve into blue or violet vapours.

It happens sometimes also near groups of spots which are endowed with great activity that perturbations are observed which are so violent that the adjacent photosphere is shaken to its foundations, cracks, and, on opening, forms sinuous crevasses which extend to considerable distances, sometimes connecting the most distant spots with each other.

[1] *Bulletin Astronomique*, vol. ii.

From the instant of their apparition the crevasses—even those which are the narrowest—show a striated and filamentous structure, which presents the greatest analogy with the penumbræ of spots; only, instead of inclining and forming a sort of slope like that on the penumbra, the filaments which form entirely the sides of the crevasses are vertical, and are all directed towards the centre of the sun.

When these crevasses have a certain duration they widen sometimes here and there, especially when they bifurcate and send branches in another direction. In this case it is not rare to see forming a strait and lengthened umbra when, at the same time, the vertical filaments having now more room raise their lower extremities.

We have seen that the last act in the history of a spot is its invasion by the faculæ. These faculæ remain long after the spot has entirely closed up, and in this connection it is important to remark that new spots very often break out in the old place. These of course, unlike the first spot in that position, will appear to be preceded by faculæ.

There is a great deal more that I might say about spots. It is a very tempting subject, but there is so much more to be referred to. The papers which have recently been printed by the Rev. S. J. Perry[1] and M. Trouvelot represent some of the most careful modern examination of the solar surface, and there is really a very great deal to be learnt from them; and fortunate it is that much which this new work has brought out in the plainest way has reference to a region of fact of very great importance to any one who wants to be able to answer for himself, as well as he can, the question, What is a sun? For instance, M. Trouvelot discovered about ten years ago that, although, as we shall see presently, ordinary sunspots have a very definite place of their own on the sun, there is a kind of spot which is not so confined. These he calls veiled spots; and I gather from his description that his opinion is that the photosphere is driven down there to a certain extent, but not driven down sufficiently to give us the dark appearance which we get in the other cases.

Spots caused by Descent of Cooled Material

It has already been suggested in preceding paragraphs that in the spot region we cannot really be dealing with any violent changes of pressure, but we may be dealing with very violent changes of temperature. We can see that it is the most natural thing in the world to suppose that in an atmosphere like the sun's, seeing that there is enormous radiation, and therefore cooling at the exterior, there must be a descent of solid particles into the interior heated region. Now, can we associate this with spot phenomena?

Yes, we can, and we are absolutely driven to it. We have already seen that the spot, when it travels over the limb, is a hollow. We also find when we examine a spot with the spectroscope that certain vapours get very much denser, as if they were being crushed together into a certain limited region either by an upthrust or a downfall. Which? Well, the spectroscope answers that question for us quite perfectly, because it shows that the vapours are absorbing, and therefore that they are cooler than the photospheric material immediately underlying them, and that they have not an excess of radiation, as they would have if they came up from below; the spectroscope then certainly justifies the view that a spot is really the result of a downrush; the vapours there are *cooler*, as they should be if they come from a cooler place; they are *denser*, as they should be, if they are descending rapidly into a place which is more or less confined; and, more than all, the change of the refrangibility of certain lines enables us to determine roughly the rate at which these descents take place. A very common velocity is 30 miles a second—not 30 miles a minute or 30 miles an hour, but 30 miles a second.

Our final idea with regard to the spots then is that they are depressions, that in fact we may regard them as shallow saucers or cups filled with the cooler vapours brought from the upper regions of the solar atmosphere. This is merely a physical conception. What we have next to do, if possible, is to add a little

[1] In the *Astronomical Register*.

chemistry, to make a more or less detailed examination of the materials—of the various chemical substances—in them.

The Chemistry of the Spots

Now from what has been already said we at once see that if we get a downrush of solid bodies, such as cooled iron masses which are derived from the condensation of the iron vapour, and which we may regard as solar meteorites, from the top of the sun's atmosphere down to the photosphere, we shall have, if that quantity be great enough in the spot region, a considerable dimming of the sun's light, by reason of the fact that we have an infinite number, or a very large number, of solid bodies stopping the light from that particular part of the sun. We shall have in that way then a continuous absorption of the sun's light; that is to say, the red light, the yellow light, the green light, the blue light, and so on, will all be more or less stopped, and that part of the sun will, from that cause alone, look dimmer. Further, if we have any vapour approximating in molecular structure to the chlorine vapour to which I drew your attention before, we shall have an absorption of another kind; we shall have a special stopping of the blue light of the sun, making, therefore, the sunlight yellower than it otherwise would be. Again, if we have other substances associated with these spots in the state of fine vapour in a state of incandescence, we shall have such absorption indicated by the darkening of certain of the Fraunhofer lines, and by the widening of them as well as the darkening of them if the quantity of any particular vapour is considerable, and we shall also get new lines if new substances are produced or their existence revealed by these conditions.

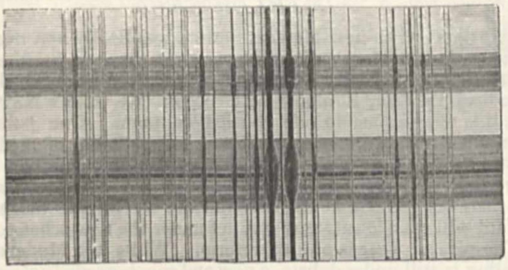


FIG. 7.—The spectra of two sunspots, showing the general darkening, and that certain lines are widened while others are not.

Now, I propose with regard to this point, seeing that our time is limited, to confine myself to the observations that have been made on the sun's spots at South Kensington since the year 1879. From that period some 700 spots have been observed. Of that number some 200 have been discussed; that is to say, maps have been made, and we have endeavoured to see along which line it was best to push on the work. But this climate of ours is not a particularly good one for observations of this kind, especially in London, because there is a good deal of smoke, and it is almost as difficult to see through a smoke cloud as it is through one of the ordinary kind. Still, in that time a considerable number of observations have been made altogether; and, to guarantee us as far as possible against bad climatic conditions, what has been done in the case of each spot has not been to observe all the lines which are specially affected, but to content ourselves with getting the results with regard to twelve lines, six in the green and yellow, and six in the blue. In that way, as these observations can be recorded in about an hour, all the observations made from 1879 to the present time are strictly comparable.

Before I state exactly what results we did get it is worth while for one moment to consider what results we should get if the old view of the chemical structure of the solar atmosphere were correct. This view is that most of the absorption which produces the Fraunhofer lines in the solar spectrum, especially those due to the absorption of the vapours of chemical substances of high atomic weight, takes place close to the photosphere, which is practically the place where the spots live. Therefore we should expect to see:—

(1) The same lines constantly thickened, as the ordinary solar spectrum is constant.

(2) The same lines of a substance widened in all spots, in which we have evidence that that particular substance is present, or the lines thinning out in all cases in the same order.

(3) No lines but those visible in the general spectrum.

(4) Motion indicated by one line of a substance indicated by all.

If the old view were true, that we have iron vapour among the other vapours in the atmosphere of the sun—nickel vapour, magnesium vapour, and so on, it would not be at all out of the way to suppose that some spots might chiefly consist of iron vapour, whereas another spot might be chiefly filled with nickel vapour, or with magnesium vapour, and so on.

With reference to (2) it may be explained that in the case of a spot which we can imagine to contain a very large quantity let us say of iron vapour, and a very small quantity of magnesium vapour; by a laboratory process which had been worked out before this work was commenced, it was easy to make a rough, but still a very useful, quantitative guess as to their relative proportions, because it has been found in laboratory work that if we only have a very small quantity of one vapour, let us call it vapour *a*, in a mixture of other vapours, *b*, *c*, and *d*, then we shall not get all the lines of *a*; we shall only get some of them, the longest lines; and if the quantity *a* is very small indeed, then we shall only get one line—the longest, in the spectrum of the vapour.

The method of mapping adopted may next be stated. In order to get as much light as we could out of the work, first of all the Fraunhofer lines were mapped in a manner which enabled anybody who took the trouble to look at the map to see which was darkest. In addition to those Fraunhofer lines information is given showing the origin of them.

I should tell you that it has been found since Kirchhoff's first researches that it does not do to talk about the spectrum of a substance as if it were an unchangeable thing. To be precise we must refer to the spectrum at the temperature of the arc; or at the temperature of the electric spark with a jar or without a jar; or at the temperature of the oxy-hydrogen flame. These spectra are very different indeed, not with regard so much perhaps to the actual lines which we see in any case, but chiefly with regard to the intensity of the lines as seen in one spectrum and in the other.

Thus it was useful to compare the lines of a substance as seen in the arc and spark with that seen in the spots, and that, so to speak, formed the ground-plan of the maps. The work to be done was to observe all the lines most widened in a region of the spectrum, and see whether they were absolutely unchangeable or whether they were not.

The diagram shows a part of one of these maps dealing with the first 100 observations. The Fraunhofer lines are at the top; the lengthening of the lines representing the intensity, that is to say, the longest line is the darkest. Below are the lines of the substance being specially studied seen in the electric arc, the longest being the brightest; and lower still the lines seen in the electric spark, the longest line also being the brightest.

We observe in the first place that there is a very considerable difference in these two spectra. We have a considerable number of lines seen in the arc, and seen in the solar spectrum among the Fraunhofer lines, which are not seen in the spectrum of the spark, the temperature of which of course is assumed to be very much higher than the temperature of the arc.

Again we may have a very faint line at the temperature of the arc, which is considerably intensified when we pass to the temperature of the spark. There are, again, other lines seen nearly of the same length both in the arc and in the spark.

Now, when we first mapped the spot observations, the maps did not indicate the origin of the lines, and when there was a great variation in the lines discovered it was a fair thing to say that the explanation lay in the fact that some of the lines belonged to one substance, and some to another. Let us call those two substances *a* and *b*. In some spots we have more of *a* and in other spots we have more of *b*. That of course was very good reasoning, so good that it was necessary to undertake a complete discussion in the case of each element. In this case the spot lines studied are not all the lines which were seen in spots, but the lines of one substance. Now the moment this work was begun strange results appeared, and the matter became difficult, because we should have imagined *a priori* that if the same substance were always present in the spot we should always have got the same spectrum, or, at all events, a spectrum along that line to which I have already referred, viz., that if the relative quantity of the vapour were less the number of its lines would be reduced, and at last when the quantity was the least possible the number of lines would be the least possible. I must call your attention to the fact that we found *inversions*, as they are now called; that is to say, to take an instance, if we represent three lines of a spectrum by *a*, *b*, and *c*, we have found among the most widened lines in spots *a* without *b* and *c*, *b* without *a* and *c*, and *c* without *a* and *b*. Now that is a condition of things impossible to understand or explain on the old view.

We next continued the discussion over another region of the spectrum, and we found that the result held absolutely good, that is to say, in other regions we got these same inversions. If we look at a map belonging to another period, although the lines change, the inversions remain, and the lines behave very much in the same way as the other. This result is quite constant for all regions of the spectrum examined. Hence, finally, we learn that these inversions hold good for different periods, and for different parts of the spectrum; and we have found that spectroscopically any one vapour in the spots behaved in exactly the same way as various mixtures of many vapours would be bound to do.

The result of this inquiry with regard to chemical substances which have been most carefully worked out, is indicated in the accompanying table, giving the result of the work for two years from 200 spots.

Statistics of the most Widened Lines seen in 200 Sunspots at Kensington

	Total number of lines in part of spectrum discussed	Total number of lines widened
Iron	172	72
Titanium	120	38
Nickel	24	9
Zinc	19	5
Cobalt	17	3
Calcium	17	7
Chromium	15	9
Molybdenum	14	1
Tungsten	14	2
Manganese	13	4
Platinum	12	1
Barium	10	1
Copper	10	1
Sodium	7	2

In these 200 spots out of 172 lines of iron which we might have seen only 72 were observed altogether; out of 120 lines of titanium which we might have seen only 38 were seen; and then the number goes on decreasing: 24 in the case of nickel, of which 9 were seen; 19 in the case of zinc, of which 5 were seen; 13 of magnesium, of which 4 were seen; 12 of platinum, of which 1 was seen, and so on.

The final upshot is, therefore, that at the spot-level we do not see the Fraunhofer spectrum, as we ought to do on the old theory. What we do see is a small percentage of the lines, and we see them under conditions which are entirely unexpected. No one, I think, who knew anything about spectrum analysis would have anticipated the result which we have got at Kensington in these 700 observations.

These, though the earlier results, are not the only results which we may hope to get by going on with the work. At present we have limited ourselves to recording the dates of the spots. But this is not enough; we must know the actual positions of the spots on the sun. We must note whether each particular spot is in the northern hemisphere or in the southern hemisphere, with the view of determining whether there is any chemical difference between the north part of the sun and the south part; and then again we shall have to compare the latitudes of spots, with the view of determining whether there is any difference in the chemistry of the spots according to the latitude. I may tell you that we are working at that particular point just now, and it really does look as if the sudden changes in the spectra recorded may have been due to the fact that the spots compared were spots varying very considerably in latitude, and it would not surprise me to find that spots which are very like each other in their spectra will be found to be situated more or less in the same degree of latitude,—whether the same degree of latitude north or south we do not know. And there is another question, too. I pointed out that there is a considerable number of lines seen in the spectrum of the arc which are left out of the spectrum of the spark. Now, will that help us at all in our inquiries? I think perhaps it may. Everybody assumes that the electric spark is hotter than the electric arc. If that be so, the lines which we see at the temperature of the arc, and which we do not see at the temperature of the arc only, may represent the lines due to cooler vapours—more complex molecular groupings it may be, which can exist in the cooler temperature, but which entirely break up on the application of a higher one. If that be so we shall be able to sort out the spots more or less according to their temperature.

Though the results have not been shown on the maps, the lines visible in the spectrum of some substances at the temperature of the oxy-hydrogen jet have been observed. Everybody assumes that the temperature of the oxy-hydrogen jet is lower than the temperature of the electric arc or spark; so that, if we can get a spot which gives us those lines thickened only which we see at the temperature of the oxy-hydrogen jet, we should be perfectly justified, I think, in saying that that was a relatively cool spot; whereas, if we saw a spot which only had those lines thickened which are intensified on the passage from the temperature of the arc to the temperature of the spark, we should be justified in saying that that spot was very much hotter. I only throw this out as an indication of the kind of result which probably future working and future thought will bring out, and that we are by no means at the end of the work yet.

J. NORMAN LOCKYER

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The new Medical Statute was finally approved by Convocation on March 16. The scope of the new Statute and its bearing on the study of medicine at Oxford were so clearly described by Prof. Burdon-Sanderson in last week's NATURE, that it is unnecessary to refer further to them. One point insisted on by the Professor, that the present student of medicine wastes his first year over Pass Moderations, has not yet been corrected. The Moderations Committee are still deliberating, but there seems little doubt that students of Natural Science in Oxford will receive substantial relief under the new scheme.

The present year is one of reform. While the Moderations question is still under debate, a new and much-needed reform has been sprung upon the University. The old Examination in the Rudiments of Faith and Religion has by common assent become out of date. Last week the preamble of a new Statute was passed *nemine contradicente* in Congregation. We must wait till next term to learn the fate of the Statute itself. It seems time that the University should grant degrees without demanding an intimate knowledge of the Thirty-nine Articles.

CAMBRIDGE.—It has been decided to establish a Tripos Examination in Engineering, to be combined with the present Natural Sciences Tripos. The general basis is that, as an alternative to the present First Part of the Tripos, an examination in certain mathematical subjects useful in engineering, physics, chemistry, and theory of structures shall be held, to be followed by a practical examination. Those who pass this will be entitled to a degree in honours. A later examination, concurrent with the second part of the Natural Sciences Tripos, is to consist of advanced papers in Physics, Chemistry, and Engineering, distinction in one or more of which is to entitle a student to a first class. When the complete scheme is published we shall give full details.

SCIENTIFIC SERIALS

The Journal of Physiology for November 1885, vol. vi. No. 6, contains:—On a double differential rheotome, by Dr. W. D. Samways (plate 7). The instrument is described and figured.—On the blood of Decapod Crustacea, by Dr. W. D. Haliburton (plate 8). Assisted in part by a grant from the British Medical Association, the author has studied the blood in the lobster, the edible crab, the crayfish, Astacus, and *Nephrops norvegicus*; and he treats of its colour, constituents, and coagulation. He ascribes the clot as due to the formation of a body scarcely to be distinguished from the fibrin of vertebrate blood, and believes that its formation is due to a ferment action, which latter is derived from the amœboid corpuscles of the blood. At the close of the memoir the author treats of the comparative aspects of crustacean blood, and gives a table of the invertebrates in which hæmocyanin and hæmoglobin have been found.—On the nature of papain and its action on vegetable proteid, by Dr. Sidney H. C. Martin. The proteids present in papain are globulin and albumin, and two forms of albumose. No peptones were found.—Regarding the influence of the organic constituents of the blood on the contractility of the ventricle, by Dr. Sydney Ringer (plate 9). He infers that the arrest of contractility with a saline solution is not due to the removal of pabulum to support the contractions, but that lime and potassium salts are necessary ingredients in a circulating fluid to supply the conditions essential to the change occurring during a contraction, there being stored up in the muscular tissue a material to carry on contractions which cannot be washed out by a fluid circulating in the heart cavities.—On the nature of glomerular activity in the kidney, by J. G. Adami. It would seem that the glomerular epithelium has properties of a definite secretory nature; they may even be regarded as (in the dog) having powers of a selective secretory nature.—Plethysmographic and vaso-motor experiments with frogs, by Dr. Fred. W. Ellis (plates 10 and 11).—On some vaso-motor functions of the spinal nerves in the frog, by W. Horscraft Waters.

The Journal of Anatomy and Physiology for January 1886, vol. xx. part 2, contains:—Prof. Macalister, morphology of the arterial system in man, part i.—R. Austin Freeman, the anatomy of the shoulder and upper arm of the mole (plate 5).—Dr. Hans Gadow, on the reproduction of the carapax in tortoises (plate 6). In the case experimented on, the dermal armour was cast off, after injury, down to the soft cutaneous layers; the bulk of these produced cutis, which then underwent the normal process of ossification, until at last a new complete armour was formed. The author cites, as an analogous case, "the reproduction of bark from the *whole surface of the cambium* laid open after the destruction of the old cortex." Is this so?—Dr. A. M'Aldowie, on the development and decay of the pigment-layer in birds' eggs.—Dr. D. J. Cunningham, the connection of the os odontoideum with the body of the axis.—Dr. R. W. Shufeldt, on the skeleton of Geococcyx (plates 7-9); a very full account of the skeleton of this rare bird.—Dr. Noël-Paton, relationship of urea-formation to bile-secretion; part ii. of these important experimental researches. The formation of urea in the liver bears a very direct relationship to the secretion of bile by that organ.—Dr. W. Hunter, recent histological methods.—Prof. W. Turner, the sacral index in various races of mankind; makes two classes—where the sacral index is below 100 (Dolichohieric), and where it is above 100 (Platyhieric).—Dr. J. L. Gibson, the blood-forming organs and blood-formation, part ii.

Zeitschrift für wissenschaftliche Zoologie, Band xliii. Heft 1 (Leipzig, December 31, 1885), contains:—Prof. A. Kölliker, histological studies of Batrachian larvæ (plates 1 and 2). Almost forty years ago Prof. Kölliker published his first account of the development of the Batrachian tissues, but the improvement in methods of research and the expansion of knowledge as to nerve-bundles and other endings have caused him to alter his opinions on several matters, and in this memoir we find his latest views on the structure, development, and terminations of the nerves; also some general considerations of the structure of the nerve-fibre and on the development of the blood- and lymph-vessels.—W. Schwarze, on the post-embryonal development in Trematodes (plate 3). These researches were made on *Cercaria armata* and *C. echinata* from *Limneus stagnalis*, and on *C. ornata* and *C. spinifera* from *Planorbis corneus*. A useful bibliography of the literature is appended.—Hermann Uhde, on the dorsal pore of the terrestrial Oligochæts: a contribution to the histology and classification of the Lumbricidæ (plate 4). In this memoir, in addition to a very detailed list of the literature of the subject and to a chapter on anatomical details, we have an account of the various species, based on materials collected from various parts of the world.—Dr. Deichler, on Protozoa parasitic in the sputa of whooping-cough.—Dr. E. Witlaczil, on the morphology and anatomy of the Coccidæ (plate 5).

Morphologisches Jahrbuch (*Gegenbaur's*), Band xi. Heft 3 (Leipzig, 1885), contains:—Dr. Béla Haller, researches on the marine Rhipidoglossa (plates 17-24), part ii. The first part of Haller's researches appeared in vol. ix. The present part treats of the structure of the central nervous systems and their envelopes. The material operated on was obtained at Trieste from Fissurella, Haliotis, and Turbo, and the conclusion is arrived at that without doubt the nerves throughout this group of Mollusca have a double origin.—Dr. H. Virchow, on the form of the plicæ of the ciliary body in mammals (plate 25). These folds, so comparatively small in the human eye, are largely developed in the rabbit.—Dr. W. Pfitzner, on the division of the nucleus in Protozoa (plate 26). These observations were chiefly on the nuclei in *Opalina ranarum*, and show the general similarity of the kariokinesis in this Protozoon with that in Metazoa.—Dr. G. Baur, notes on the "astragalus" and the "intermedium tarsi" in mammals (plate 27). As introductory to these notes a very copious account of the literature of the subject is given.—Among the short notices are: on the nerve-canal in the humerus of the Amniota, by Prof. U. Fürbinger; and on the rudiment of a septal nasal gland in man, by Prof. Gegenbaur.

Rendiconti del Reale Istituto Lombardo, January 21.—On the grape-vine mildew; observations and remedies, by Prof. Gaetano Cantoni. Although usually supposed to have been for the first time introduced into Europe from America about 1877, the writer quotes a correspondent in the *Bulletin* of the French Agricultural Society, who states that this disease was known in Alsace under the name of *mildau* over forty years ago. From Alsace it passed to America, where the name became Anglicised, recently returning to Europe under the designation of grape-vine mildew. The best prophylactic remedies hitherto discovered are the sulphate of copper and milk of lime, applied either separately or in combination about the beginning of June, and repeated, if necessary, towards the end of August or beginning of September.—On the formation of dew, by Prof. Giovanni Cantoni. It is shown that the theory recently communicated by Prof. Aitken to the Edinburgh Royal Society and described in NATURE for Jan. 14 (p. 256), agrees with the conclusions already arrived at by Fusinieri, Melloni, and other Italian meteorologists.—Summary of the meteorological observations made at the Brera Observatory, Milan, during the year 1885, prepared by E. Pini.

Mittheilungen der Naturforschenden Gesellschaft in Bern, Nos. 1092-1132 (1884-85).—Wind and precipitates in Bern (from records of Bern Observatory during fifteen years), by Herr Benteli.—On a case of rapid hole-formation in rock, by Herr Baltzer.—On lake-balls, by Herr Coaz.—On the theory of trisection of angles, by Herr Moser.—On the termination of nerves in striped muscles of man, by Herr Flesck.—On a case of loess in Canton Bern, by Herr Baltzer.—On the oldest map of Switzerland of Ægidius Tschudi, by Herr Graf.—Mathematical researches on the colour of thin gypsum plates in polarised light, by M. Jonquière.—On the poisoning with *Amanita phalloides* in Bern in 1884, by Herr Studer, jun.—On the occurrence of the vascular wave in the carotid-curve, by Herr Mützenberg.—Contributions to a comparison of the brain-fissures in Carnivora and Primates, after examination of a lion's brain, by Herr Familiant.—On the chemistry of food-stuffs, by Herr Fueter-Schnell.—On a new occurrence of rock-crystal in Switzerland, by Herr von Fellenberg.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft in Lucerne, September 1884.—We note here the President's (Herr Suidter-Langenstein) opening address, dealing with the Lucerne region in geological, meteorological, and biological aspects; also two interesting reports on prize competitions—one relating to a climatology of Switzerland, the other to the deep-water fauna of Swiss lakes.

Journal de Physique, February.—On refrigerating mixtures and the principle of maximum work, by M. Potier.—On the critical temperatures and the pressures of some gases, by MM. Vincent and Chappuis.—Researches on the freezing temperature of solutions, by M. Raoult.—On the formula of plane gratings, by M. Branly.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 10, 1885.—"On the Magnetisation of Steel, Cast Iron, and Soft Iron." By John W. Gemmell.

In this paper the author describes and gives the results of a series of experiments upon particular specimens of iron and of steel. The specimens consisted of wires of "soft Scotch iron," "common wire," "charcoal iron," and "soft steel," with bars of cast iron and malleable iron; and the object of the investigation was to find the difference between these, with respect to the intensities of their total and residual magnetisation, due to different degrees of magnetising force.

The apparatus was arranged, and the experiments made, according to a simple magnetometric method fully detailed in the paper. The magnetising currents were derived from a battery of Thomson's tray Daniells, so arranged that any number of cells could readily be placed in the circuit.

The results represent the effect of a current gradually increased from 0 to the maximum, gradually diminished to 0 again, and of the same process repeated with a negative current. They are shown in curves, the abscissæ of which are proportional to the magnetising forces, and the ordinates to the magnetisation produced. Figures are given by which to reduce these values to absolute measure.

It has been found that the "charcoal iron" has the highest magnetisability, and the "soft steel" the lowest; while that of the "soft Scotch iron" approaches the former. With regard to retentiveness, the "charcoal iron" shows the least, and the "soft steel" the greatest. Annealing the latter, however, has the effect of bringing it very near the "common wire," both in respect of magnetisability and retentiveness. The two specimens of cast iron differ considerably. The malleable iron bar shows a very much higher magnetisability than the cast iron ones, and its residual magnetisation was so low that it could not be observed with the same arrangement of apparatus.

These curves also present certain anomalies which are worth investigation. The space about the zero on an enlarged scale is affixed to each set to show its peculiarities more clearly.

In the curves representing the residual magnetisation we find a loop between the direct and return curves, more or less marked in all the diagrams. A similar feature presents itself in the curves of total magnetisation in two of the diagrams, and there seems to be a tendency always to form this loop.

In that part of the return curve which represents the effects of the small magnetising forces, the residual magnetism is seen first to take a greater value, and then to diminish again just before the zero of magnetising force is reached. This may be observed also in the negative return curve.

January 21.—"On Radiant Matter Spectroscopy: Note on the Spectra of Erbia." By William Crookes, F.R.S.

I have recently succeeded in getting the earth erbia in a sufficiently pure state to allow me to examine its phosphorescent spectrum without the interference which might be produced by the presence of yttria, samaria, holmia, thulia, Yα, or ytterbia. As in the case of yttria,[1] the spectrum is best seen when erbic sulphate is heated to redness and submitted to the electric discharge in a high vacuum. The addition of calcic sulphate interferes with the purity of the spectrum. In this respect erbia differs from samaria, as the latter earth seems to require the presence of some other metal to develop its phophorescent properties.

The phosphorescent spectrum of erbia consists of four green bands, of which the following measurements have been taken:—

Scale of spectroscope	λ	$\frac{1}{\lambda^2}$	Remarks
9·750°	5564	3230	Approximate centre of a wide band, shading off at each side.
9·650	5450	3367	Approximate centre of a band, narrower and somewhat fainter than the first band.
9·525	5318	3536	Approximate centre of a narrow band, bright and moderately sharp on each side.
9·400	5197	3702	Approximate centre of a band, similar in appearance to the first band, but brighter.

These bands do not correspond in position to any in either the yttrium or samarium spectrum. The nearest approach to a coincidence is between the first erbia green and the samarium green, but when the two spectra are examined one over the other it is seen that the samarium band is less refrangible than the erbium band.

[1] *Phil. Trans.*, part iii., 1883, p. 913 (par. 71).

The first green of Yα occurs midway between the first and second greens of erbia, and the second Yα green comes between the second and third erbia greens.

Pure erbia is of a beautiful rose-pink colour. When illuminated by sun or electric light and examined in the spectroscope it gives a spectrum of black lines and bands as sharp and distinct as the Fraunhofer lines. It is strange that this most characteristic property has been recorded by so few observers. Indeed, the only notice of it I have come across is a passing remark of Prof. Clève's that "the light reflected by dry erbia shows absorption bands."

The absorption spectrum given by a solution of pure erbic chloride differs in some respects from the drawings mapped from older observations, as the absorption lines of holmia and thulia are absent. The fine group of lines in the green of the reflection spectrum is also absent in the absorption spectrum.

The spectrum of bright lines emitted when erbia is rendered incandescent in the blow-pipe flame has been often observed, but the lines in this case are luminous on a fainter continuous background, and are not particularly sharp, whilst the reflection spectrum consists of black lines sharply defined on a continuous spectrum.

February 4.—"A Further Inquiry into a Special Colour-Relation between the Larva of *Smerinthus ocellatus* and its Food-plants." By Edward B. Poulton, M.A., of Jesus and Keble Colleges, Oxford. Communicated by Prof. J. S. Burdon-Sanderson, F.R.S.

The object of the paper was to give an account of the investigation upon this subject which had been undertaken in 1885, having been continued from the previous year (described in *Proc. Roy. Soc.*, No. 237, 1885, p. 269). The points which had been raised, and upon which evidence was desired, were as follows:—(1) The larvæ are generally uniformly coloured on the same food-plant, but sometimes there are exceptions; can any of these be due to the hereditary transmission of the influence of food-plants upon the parent larvæ? (2) Is the colour of the larva influenced by the colour of the environment which, acting upon some sensory surface, directs the kinds and amounts of pigments deposited, or absorbed from the food? (3) It was also important to test the effects of certain new food-plants and of others about which the evidence was conflicting; and (4) to look out for any indications which would throw light upon the red-spotted varieties, or upon the existence of individual variation of any kind, under similar conditions of parentage and food; and (5) to inquire into the periods during which the larvæ are most susceptible to the colour-influence.

Experiments in 1885.—These were divided into five series, as the larvæ came from five batches of eggs. The differences between the larvæ are expressed in five degrees: white, whitish-intermediate, intermediate, yellowish intermediate, and yellow. *Series I.* Eggs were laid by a moth bred from a larva which had been a typical whitish variety (as was also the case with the male parent). The resulting larvæ were whitish (5) upon *Pyrus Malus* (var. *acerba*), intermediate (1) upon *Populus tremula* and another species of poplar, intermediate (1) upon *Salix babylonica*, and whitish (2), although they did not become adult, upon *S. rubra* and other similar species of sallow. In this series the hereditary influence on the side of white is seen to be strongly marked on comparing the effects with those shown in the other series and in the parent larvæ (see former paper). *Series II.* Eggs were laid by a moth bred from a whitish-intermediate larva, without any act of coitus having been witnessed (although male moths were present). Most of the eggs shrivelled up, but a few hatched, and form the larvæ of this series. Subsequently coitus was induced (artificially), and a large number of fertile eggs were laid which are considered under the next series. The larvæ of Series II. were whitish (4) upon *Salix viminalis*, although not to such an extent as upon apple, and yellowish-intermediate (1) upon *S. Smithiana* and another sallow with similar leaves. These results are rather irregular, for the former larvæ were whiter than the parents, the latter yellower than it is probable that the parents would have been on the same tree. But the results were not unusual in themselves. *Series III.* The female parent was the same as in Series II.; the male parent was bred from a typical whitish larva. The resulting larvæ were whitish (6) upon ordinary apple, and upon the same with the leaves sewn to expose the under sides (1), and to expose the upper sides (3) (none of these reached maturity, and the last lot were especially young when they died); whitish (4) but immature upon crab (var. *acerba*); whitish-intermediate

(5) upon *Salix viminalis;* white (1) but immature upon *S. viminalis*, sewn to show the under sides; yellowish-intermediate (2) but immature upon *S. alba;* whitish-intermediate (4) but mostly immature upon *S. Smithiana* and similar leaves; intermediate (1), yellowish-intermediate (5), and yellow with traces of the red spots (1) upon *S. cinerea;* intermediate (1) upon *Populus nigra;* intermediate (6) and yellowish-intermediate (2) upon *S. triandra;* yellowish-intermediate (10) upon *S. triandra* without the bloom on the under sides of the leaves; yellowish-intermediate (4) upon *S. babylonica* (when the larvæ were young and more numerous, one of them in the fourth stage possessed traces of the upper row of rust-coloured spots, and was a whitish variety: it was put upon apple and died as an intermediate variety when advanced in the last stage); intermediate (1) and yellowish-intermediate (3) upon *S. rubra.* The results of these experiments were mostly what might have been anticipated from the colour of the leaves. The especially interesting results were: the effects produced by the sewn leaves of *S. viminalis* and the bloomless leaves of *S. triandra* as compared with the normal leaves in both cases, and the occurrence of red spots on two larvæ—one, the only yellow variety obtained, and the other an intermediate variety. The indications of individual variation in the *S. cinerea* larvæ were also interesting. *Series IV.* All these larvæ died before trustworthy observations could be made; they had been reserved for experiment: the ocelli of many were covered with a harmless opaque layer (lamp-black and McGuilp) in the attempt to isolate the sensory surface which is affected by the colour of the environment. Others were fed upon apple and *S. rubra*, and a certain number were changed at every stage, so as to find the periods during which the larvæ are most susceptible to the surrounding colour. The failure of all these was due to the season and not the conditions of the experiment. *Series V.* The female parent was bred from a yellowish-intermediate larva, the male parent from a yellow larva. The resulting larvæ were, intermediate (1) upon *S. viminalis* sewn to show the upper sides of the leaves; intermediate (1) and yellowish-intermediate (1) upon *S. cinerea.* The first result was interesting, but the second shows that the larvæ did not tend much towards yellow. The hereditary influence towards yellow in this case depends chiefly on the male parent, and how far this element asserts itself in opposition to the other sex is quite unknown in this class of experiment.

Results of the Experiments.—The existence of hereditary influence is, on the whole, demonstrated. The parent larvæ tended towards white, and out of the 75 larvæ of the next generation, there was only one yellow variety. Yet the latter were, on the whole, rather more influenced in the direction of yellow than the parents, when the plants tended this way. The results were the same as in the parents when very powerful white influence was used (apple, &c.) The comparison of the different series was less satisfactory, but the hereditary differences were mostly delicate, except between V. and the other series.

Series I. and III. compare favourably, while in II. the parentage is very obscure. There is conclusive proof that it is the colour of the leaf, and not its substance when eaten which influences the larval colours.

Conflicting evidence as to the effect of plants is cleared up. *S. triandra* produces yellow; and Mr. Boscher's white larvæ, said to have been found upon this plant, occurred upon the very similar, but much whiter, *S. alba.* Previous conclusions as to *S. Smithiana* and *S. babylonica* are confirmed. The existence of individual variation with similarity of parentage and conditions is now proved, although it is rare and slight (8 out of 75 in 1885, 0 out of 23 in 1884). Thus it cannot explain the extreme differences met with in the field (1884), *e.g.* yellow upon apple, &c. The colours of the larvæ are determined by (1) the food-plant; (2) hereditary influence; (3) individual variation. Slight differences may be caused by the latter; extreme differences by the two former. The uncertain action of (1) will be shown later. The two red-spotted larvæ were very interesting, showing how the character tends to appear on the yellow varieties (the only yellow one produced), and yet that it may appear upon the other varieties (which is a new experience).

Observations in the Field in 1885.—(1) White variety upon ordinary apple; (2) white and (1) intermediate upon *S. viminalis;* (1) yellowish-intermediate upon *S. linearis* (Forbes); (1) yellow upon *S. incana* in Switzerland; (1) white upon *S. alba* (ordinary) in Switzerland; (1) yellowish-intermediate upon var. *S. alba* (? *vitellina*) in Switzerland; (2) yellow upon var. *S. alba* in Switzerland; (1) whitish-intermediate upon *S. Smithiana*; (4) yellow and (1) whitish-intermediate upon *S. cinerea;* (4) yellow upon *S. triandra;* (1) yellowish-intermediate upon *S. babylonica;* (12) yellow and (3) yellowish-intermediate upon *S. rubra.* All, except the five in Switzerland, were found at Oxford.

Conclusions from Captured Larvæ; Reconciliation of Conflicting Evidence.—The results recorded above were very uniform. Only in the case of *S. cinerea* was there any great difference between the larvæ on the same tree, for the Swiss varieties of *S. alba*, which produced yellowish larvæ, had leaves resembling *S. rubra* rather than the ordinary English *S. alba*, with one exception (which produced the white larva). At the same time there were two instances which perplexed me for a long time, and finally suggested the explanation which clears up the greatest difficulty in the way of the theory—the conflicting evidence (Mr. Boscher's and my own) with regard to the action of *S. viminalis.* These instances were, the yellowish intermediate larva upon *S. linearis* and the yellow one upon *S. incana.* Both the trees had small narrow leaves with very white under sides, and yet the larvæ were not white. *S. linearis* is whiter than apple or any sallow that I have seen. Then I remembered that the single yellow larva I had found upon *S. viminalis* (in 1884) was upon a tree with very small leaves; finally, I had the opportunity of looking at twigs from the trees upon which Mr. Boscher had found about eighteen yellow larvæ. These, too, bore very small leaves, although they were as white as usual on the under sides. This association of yellow larvæ with small leaves (although white) suggested the following explanation. It is the *immediate* environment almost in contact with the larva which has the greatest effect upon it, and the longer it acts the more extreme will be the result. The larvæ habitually rest upon the under sides of the leaves, until their size and weight render it impossible for them to do so longer; then they retire to the stem. Hence the larvæ rest for a much longer period of their lives upon large and strong leaves than upon small ones, and therefore, in the former case, the effect of the white under sides is much more powerful, for after the larva has reached the stem the immediate environment is less exclusively white, and may be largely formed by the green or yellowish upper sides of the leaves (depending upon the arrangement of the latter). This completely explains the conflicting results upon *S. viminalis*, for there is an immense difference in size between the leaves of the two forms upon which the two varieties of larva have been found; and the arrangement is also different, tending to produce a white environment after the larva has gone to the stem in the case of the large-leaved trees, but not in the small-leaved forms. This explanation is valid for other food-plants in exact proportion to the difference in colour between the two sides of their leaves. Thus it is probable that it explains in a great measure the yellow effect of the small-leaved *S. cinerea*, and the much whiter effect of the large-leaved *S. Smithiana;* both having very similar leaves with white under sides. It also explains the very powerful effect of apple, with its large strong leaves, which are arranged so as to give a maximum white effect after the larva has retired, very late in life, to the stem. Another difficulty is also cleared up by this suggestion—the fact that bred larvæ in 1884 and 1885 became intermediate upon large-leaved *S. viminalis*, although they tended towards white (as shown by the effect of other plants). The long leaves were disarranged when crowded into the glass cylinders in which the larvæ were kept, and so the immediate environment of the larvæ was artificially altered when they were on the under sides of the leaves, and also on the stem. Furthermore, they were often disturbed by changing the food, and so did not rest upon the white surfaces for such long periods as in the natural state. The larvæ found in the field upon *S. rubra* and plants tending towards yellow were much more extreme varieties than those produced by breeding. This is partly due to the hereditary influence towards white in the latter case, but also probably to the white muslin which was tied over the breeding cylinders, and to the less amount of direct sunlight obtainable indoors and among the crowded leaves. In the field the larvæ habitually rest on the most exposed and tallest boughs, of which the colours are most brightened by sunlight, and such an environment therefore produces a very strong influence upon them. Such considerations suggest that it will be very interesting to breed the larvæ under coloured light, and I intend to make the experiment this summer.

Conclusion.—The whole evidence for the theory of colour-relation advanced in the present paper consists of 204 instances, of which about half were bred and the rest found in the field. Such is the evidence for the conclusion that the larva of *Smerinthus ocellatus* maintains a colour-relation with the food-plant upon which it was hatched, adjustable within the limits of a single life, and that the predominant colour of the food-plant itself is the stimulus which calls up a corresponding larval colour. This is an entirely new resource in the various schemes of larval protection by resemblance to the environment, and one which stands on a very different level from all others. In the latter the gradual working of natural selection has finally produced a resemblance, either general or special, to something which is common to all the food-plants of the larva or to some one or more of them, the larva being less protected upon the remainder. But in the former case the same gradual process has finally given the larva a power which is (relatively) immediate in its action, and enables the organism itself to answer with corresponding colours the differences which obtain between its food-plants. This action is very different from the much more rapid changes of colour in other organisms (amphibia, fish, &c.), for in them the changing colours of the environment act as stimuli, which, through a nervous circle, modify the condition of existing pigments; while in the larva the influence makes itself felt in the absorption and production of pigments rather than their modification when formed; and such a method of gaining protection is, as far as we yet know, unique in the animal kingdom. And the power is not confined to the species in which its existence has been to some extent completely proved. There are already proofs that many other larvæ can maintain a similar colour-relation, and careful observation will doubtless reveal many slight and protective differences among larvæ of the same species when found upon differently-coloured food-plants, and will prove that this power is not at all uncommon among the great body of lepidopterous larvæ which adopt the methods of protective resemblance.

February 11.—"On the Theory of Lubrication and its Application to Mr. Beauchamp Tower's Experiments, including an Experimental Determination of the Viscosity of Olive Oil." By Prof. Osborne Reynolds, LL.D., F.R.S.

The application of the hydrodynamical equations for viscous fluids to circumstances similar to those of a journal and a brass in an oil-bath, in so far as they are known, at once led to an equation [1] between the variation of pressure over the surface and the velocity, which appeared to explain the existence of the film of oil at high pressure.

This equation was mentioned in a paper read before Section A at the British Association, at Montreal. It also appeared from a paragraph in the Presidential Address (p. 14, B.A. *Report*, 1884) that Prof. Stokes and Lord Rayleigh had simultaneously arrived at similar results. At that time the author had no idea of attempting the integration of this equation. On subsequent consideration, however, it appeared that the equation might be so transformed [2] as to be approximately integrated by considering certain quantities small, and the theoretical results thus definitely compared with the experimental.

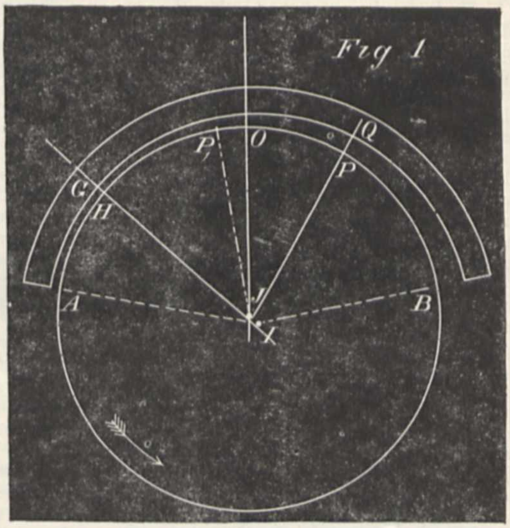
The result of this comparison was to show that with a particular journal and brass the mean thickness of the film would be sensibly constant for all but extreme values of load divided by viscosity, and hence if the coefficient of viscosity were constant the resistance would increase approximately as the speed.

As this was not in accordance with Mr. Tower's experiments, in which the resistance increased at a much slower rate, it appeared that either the boundary actions became sensible, or that there must be a rise in the temperature of the oil which had escaped the thermometer used to measure the temperature of the journal.

That there would be some excess of temperature in the oil film on which all the work of overcoming friction is spent is certain, and after carefully considering the means of escape of this heat, it appeared probable that there would be a difference of several degrees between the oil-bath and the film of oil.

This increase of temperature would be attended with a diminution of viscosity, so that as the resistance and temperature increased with the velocity there would be a diminution of viscosity, which would cause the increase of the resistance with the velocity to be less than the simple ratio.

In order to obtain a quantitative estimate of these secondary effects, it was necessary to know the exact relation between



the viscosity of the oil and the temperature. For this purpose an experimental determination was made of the viscosity of olive oil at different temperatures as compared with the known viscosity of water. From the result of these experiments an

No. of equation in the paper

[1] $$\frac{dp}{dx} = \frac{6\mu U (h - h_1)}{h^3} \quad \ldots\ldots (31)$$

in which p is the intensity of pressure, μ coefficient of viscosity, x the direction of motion, h the interval between the journal and the brass, h_1 being the value of h for which the pressure is a maximum, U the surface velocity in the direction of x.

[2] If the journal and brass are both of circular section, as in Fig. 1, and R is the radius of the journal, R + a radius of brass, J the centre of the journal, I the centre of the brass, JI = ca, HG the shortest distance across the film, IO the line of loads through the middle of the brass, A the extremity of the brass on the off side, B on the on side, P_1 the point of greatest pressure

putting

$$OIH = \phi_0 - \frac{\pi}{2}$$

$$OIP_1 = \phi_1$$

$$OIP = \theta$$

$$h = a\{1 + c \sin(\theta - \phi_0)\}$$

$$h_1 = a\{1 + c \sin(\phi_1 - \phi_0)\}$$

the equation (31) becomes

$$\frac{dp}{d\theta} = \frac{6R\mu c\{\sin(\theta - \phi_0) - \sin(\phi_1 - \phi_0)\}}{a^2\{1 + c\sin(\theta - \phi_0)\}^3} \quad \ldots (48)$$

if $\frac{a}{R}$ is small. This equation, which is at once integrable when c is small, has been integrated by approximation when c is as large as 0·5.

The friction is given by an equation

$$f = -\tfrac{1}{2}R\frac{d\theta}{dp}a\{c\sin(\theta - \phi_0)\} - \mu\frac{U_1 - U_0}{a\{1 + c\sin\theta - \phi_0\}} \quad \ldots (49)$$

This is also approximately integrated up to $c \doteq 0·5$.

ϕ_0 and ϕ_1 and c have to be determined from the conditions of equilibrium, which are

$$\int_{-\theta_1}^{\theta_1}\{p\sin\theta - f\cos\theta\}dp = 0 \quad \ldots\ldots (44)$$

$$\int_{-\theta_1}^{\theta}\{p\cos\theta + f\sin\theta\}d\theta = \frac{L}{R} \quad \ldots\ldots (45)$$

$$\int_{-\theta}^{\theta} f d\theta = \frac{M}{R^2} \quad \ldots\ldots\ldots\ldots (46)$$

where $2\theta_1$ is the angle subtended by the brass, L the load, and M the moment of friction.

The solution of these equations may be accomplished when c is small, and has been approximately accomplished for particular values of c up to 0·5, the boundary conditions as regards p being

$$\theta = \pm\theta_1 \qquad p = p_0,$$

whence substituting the values of ϕ_1, ϕ_0, c in (48) and (49), and integrating, the values of the friction and values of the pressure are obtained.

empirical formula has been deduced for the viscosity of olive oil at all temperatures between 60° and 120° F.[1]

Besides the effect on μ the temperature might, owing to the different expansion of brass and iron, produce a sensible effect on the small difference a in the radii of the brass and journal, *i.e.* on the mean thickness of the film. E was taken for the coefficient of this effect, and since, owing to the elasticity of the material, the radius would probably alter slightly with the load, m was taken as a coefficient for this effect, whence a is given by an equation[2] in terms of a_0, its value with no load and a temperature zero.

Substituting these values in the equations, the values of the pressure and friction deduced from the equations are functions of the temperature, which may be then assumed, so as to bring the calculated results into accord with the experimental.

There was, however, another method of arriving, if not at the actual temperatures, at a law connecting them with the frictions, loads, and velocities. For the rise in temperature was caused by the work spent in overcoming friction, while the heat thus generated had to be carried or conducted away from the oil film. Consideration of this work and the means of escape gave another equation between the rise of temperature, the friction, and velocity.[3]

The values of the constants in this equation can only be roughly surmised from these experiments, without determining them by substituting the experimental values of f, U, and T, as previously determined, but it was then found that the experiments with the lower loads gave remarkably consistent values for A, B, E, m, and a_0, which was also treated as arbitrary. In proceeding to the higher loads for which the values of c were greater, the agreement between the calculated and experimental results was not so close, and the divergence increased as c increased. On careful examination, however, it appeared that this discordance would be removed if the experimental frictions were all reduced 20 per cent. This implied that 20 per cent. of the actual friction arose from sources which did not affect the pressure of the film of oil; such a source would be the friction of the ends of the brass against flanges on the shaft commonly used to keep the brass in its place, or by any irregularity in the longitudinal section of the journal or brass. A coefficient, n, has therefore been introduced into the theory, which includes both the effect of necking and of irregularity in longitudinal section. Giving n the value 1·25, the calculated results came into accordance with all Mr. Tower's results for olive oil, the difference being such as might well be attributed to experimental inaccuracy, and this both as regards the frictions measured with one brass, No. 1, and the distribution of the pressure round the journal with another, No. 2.

Not only does the theory thus afford an explanation of the very novel phenomena of the pressure in the oil film, but it also shows, what does not appear in the experiments, how the various circumstances under which the experiments have been made affect the results.

Two circumstances in particular which are brought out as principal circumstances by the theory seem to have hitherto entirely escaped notice, even that of Mr. Tower.

One of these is a, the difference in the radii of the journal and of the brass or bearing. It is well known that the fitting between the journal and its bearing produces a great effect on the carrying power of the journal, but this fitting is supposed to be rather a matter of smoothness of surface than a degree of difference in radii. The radius of the bearing must always be as much larger than that of the journal as is necessary to secure an easy fit, but more than this does not seem to have been suggested.

It now appears from this theory that if viscosity were constant the friction would be inversely proportional to the difference in the radii of the bearing and journal, and this although the arc of contact is less than the semi-circumference; and taking temperature into account it appears from the comparison of the theoretical frictions with the experiment on brass No. 1 that the difference in the radii at 70° F. was

$$a = 0{\cdot}00077 \text{ (inch)},$$

and comparing the theoretical pressures with those measured with brass No. 2,

$$a = 0{\cdot}00084 \text{ (inch)},$$

or the difference was 9 per cent. greater in the case of brass No. 2.

Another circumstance brought out by this theory, and remarked on both by Lord Rayleigh and the author at Montreal, but not before suspected is, that the point of nearest approach of the journal to the brass is not by any means in the line of load, and, what is still more contrary to common supposition, it is on the *off*[1] side of this line.

This point H moves as the ratio of load to velocity increases; when this ratio is zero, the point H coincides with O, then as the load increases it moves away to the left, till it reaches a maximum distance $\frac{\pi}{2} = \phi_0$, being nearly $-\frac{\pi}{2}$. The load is still small, smaller than anything in Mr. Tower's experiments, even with the highest velocities. For further increase of load, H returns towards O, or $\frac{\pi}{2} - \phi_0$ increases. With the largest loads and smallest velocities to which the theory has been applied this angle is about 40°. With a fairly loaded journal well lubricated it would thus seem that the point of nearest approach of brass to journal, *i.e.* the centre of wear, would be about the middle of the off side of the brass.

This circumstance, the reason of which is rendered perfectly clear by the conditions of equilibrium, at once explains a singular phenomenon, incidentally pointed out by Mr. Tower, viz. that the journal having been run in one direction for some time, and carrying its load without heating, on being reversed began to heat again, and this after many repetitions always heating on reversal, although eventually this tendency nearly disappeared. Mr. Tower's suggested explanation appears to the author as too hypothetical to be satisfactory, even in default of any other; and particularly as this is an effect which would necessarily follow in accordance with the theory, so long as there is wear. For the centre of wear, being on the *off* side of the line of loads, this wear will tend to preserve or diminish the radius of the brass on the *off* side, and enlarge it on the *on* side, a change which will, if anything, improve the condition for producing oil pressure while running in this direction, but which will damage the condition on which the production of pressure in the film depends when the journal is reversed and the late *off* side becomes the new *on* side. That with a well-worn surface there should be sufficient wear to produce this result with such slight amounts of using as those in Mr. Tower's experiments before reversal seems doubtful, but supposing the brass new and the surface more or less unequal, the wear for some time would be considerable, even after the initial tendency to heat had disappeared. Hence it is not surprising that the effect should have eventually seemed to disappear.

The circumstances which determine the greatest load which a bearing will carry with complete lubrication, *i.e.* with the oil film continuous between brass and journal throughout the entire arc, are definitely shown in the theory, so long as the brass has a circular section.

The theory shows that the ultimate limit to the load will be the same with the oil-bath and with partial lubrication as Mr. Tower found it to be.

The effect of the limited length of bearings, and the escape of the oil at the ends, is also apparent in the equations.

Although in the main the present investigation has been directed to the circumstances of Mr. Tower's experiments, namely, a cylindrical journal revolving in a cylindrical brass, the main object has been to establish a general and complete theory based on the hydrodynamical equations for viscous fluids. Hence it has been thought necessary to proceed from the general equations, and to deduce the equations of lubrication in a general form, from which the particular form for application has been obtained. It has been found necessary also to consider somewhat generally the characters of fluid friction and viscosity.

The verification of the equations for viscous fluids under such extreme circumstances affords a severe test of the truth and com-

[1] An inch being unit of length, a pound unit of force, and a second unit of time, for olive oil

$$\mu = 0{\cdot}00004737e^{-0{\cdot}0221\text{T}} \quad \ldots\ldots \quad (8)$$

[2] $$a = (a_0 + m\text{L})e^{\text{ET}} \quad \ldots\ldots\ldots \quad (117)$$

[3] $$f = \left(\text{A} + \frac{\text{B}}{\text{U}}\right)\text{T} + \text{EAT}^2 \quad \ldots\ldots \quad (120)$$

A + ET represents the rate at which the mechanical equivalent of heat is carried away per unit of temperature; B represents the rate at which it is conducted away.

[1] *On* and *off* sides are used by Mr. Tower to express respectively the sides of approach and recession, as B and A, Fig. 1, the arrow indicating the direction of motion.

pleteness of the assumptions on which these equations are founded; and the result of the whole research is to point to a conclusion (important to natural philosophy) that not only in cases of intentional lubrication, but wherever hard surfaces under pressure slide over each other without abrasion, they are separated by a film of some foreign matter, whether perceptible or not; and that the question as to whether the action can be continuous or not turns on whether the motion tends to preserve the foreign matter between the surfaces at the points of pressure, as in the almost if not quite unique case of the revolving journal, or tends to remove it, and sweep it on one side, as in the action of all backward and forward rubbing with continuous pressure.

The fact that a little grease will enable any surfaces to slide for a time has tended doubtless to obscure the action of the revolving journal to maintain the oil between the surfaces at the point of pressure, and yet, although only now understood, it is this action that has alone rendered machinery or even carriages possible. The only other self-acting system of lubrication is that of reciprocating motion with intermittent pressure and intermittent separation of the surfaces to draw the oil back or to draw a fresh supply. This is important in certain machinery, as in the steam-engine, and is as fundamental to animal mechanism as is the continuous lubricating action of the journal to mechanical contrivances.

Mathematical Society, March 11.—Mr. J. W. L. Glaisher, F.R.S., President, in the chair.—Mr. L. J. Rogers was admitted into the Society.—Prof. Sylvester, F.R.S., read a paper on an instantaneous proof of the expression for the number of linearly independent invariants or seminvariants of a given type, and also of the corresponding expression for reciprocants.—Mr. E. B. Elliott read a paper on ternary and *n*-ary reciprocants, and Mr. L. J. Rogers read one entitled "Homographic, Circular, and Projective Reciprocants."—Capt. P. A. Macmahon, R.A., communicated a proof of Cayley's fundamental theorem of invariants, and Mr. Leudesdorf communicated a note by Mr. Griffiths, on the invariantisers of a binary quantic.—Mr. Tucker (Hon. Sec.) called the attention of the Society to a paper read before the Royal Irish Academy (January 26) by Dr. Casey, F.R.S., entitled "On the Harmonic Hexagon of a Triangle," in which properties established by himself for a harmonic quadrilateral were beautifully generalised and extended to the harmonic hexagon and other harmonic polygons. The harmonic hexagon is thus defined:—$A B C$ is any triangle, $A A'$, $B B'$, $C C'$ its symmedian lines, which meet the circumcircle in $A' B' C'$; the figure $A B' C A' B C'$ is the harmonic hexagon. Dr. Casey calls the triangles $A' B' C'$, $A B C$ cosymmedian triangles.—Mr. Tucker then communicated, for the Rev. T. C. Simmons, the following extensions:—Let K' be the inverse point of the symmedian point K with respect to the circumcircle, and let $K' A$, $K' B$, $K' C$ meet this circle in $A'' B'' C''$; then $A'' B'' C''$ may be called the inverse cosymmedian triangle of $A B C$. What Dr. Casey has proved for cosymmedian triangles, Mr. Simmons shows also for these inverse triangles, and the result is that the three sets of triangles have the same Brocard points, symmedian point, Brocard, "T. R.," sine and cosine circles.—Mr. Simmons also sent a construction for finding a triangle whose Brocard points and angle are given, whence he proves that *any* triangle inscribed in a certain circle and circumscribed to the Brocard ellipse has the given Brocard points for B. points.

Linnean Society, March 4.—Sir John Lubbock, Bart., F.R.S., President, in the chair.—Messrs. Gilbert C. Bourne, William H. Catlett, and Thos. A. Cotton were elected Fellows of the Society.—One of nine volumes of water-colour drawings of British plants, by the late Miss Moseley of Great Malvern, was exhibited for Miss Onslow.—A paper on *Strongylus Arnfieldi* and *S. tetracanthus*, by Prof. Spencer T. Cobbold, was read, and specimens illustrating the encysted stage of the latter exhibited. Of Arnfield's strongyle he drew attention to the morphology of the hood and its rays, the position of the vulva, and the structure of the embryo, contrasting these with those of allied forms. Regarding his observations on the four spined strongyle these may be summarised as follows:—(1) The eggs are expelled from the parent in a state of fine yolk-cleavage; (2) embryos are formed after egg expulsion, and a few days subsequently escape from the envelopes, undergoing a primary change of skin in moist earth during warm weather; (3) thereafter they live many weeks as rhabdiform nematoids; (4) in all likelihood an intermediary host is unnecessary; (5) the rhabdiform larvæ are passively transferred to their equine bearers either with fresh-cut fodder, or while the animals are grazing; (6) transferred to the intestinal canal they enter the walls of the cæcum and colon, encyst themselves, and undergo change of skin; (7) their presence in the intestinal walls is associated with certain pathological conditions, frequently fatal to the bearer; (8) ordinarily the young worms perforate their cysts and migrate to the lumen of the bowel, and indications of sex appear at this the "Trichonema stage"; (9) they next form cocoons by agglutination of vegetable debris within the gut, and undergo a third skin-casting, with intestinal metamorphosis; (10) lastly, their internal sexual organs and the completion of definite form are acquired within the colon of the host.—A paper was read by Mr. G. Murray on a new species of *Rhipilia* from the Mergui Archipelago. This was collected by Dr. J. Anderson (of Calcutta Museum) in 1882, and recently presented to the British Museum. It was found growing on mud flats at King's Island Bay. The genus *Rhipilia* was established by Kützing for the reception of two species—*R. tomentosa* and *R. longicaulis*—collected by Sonder in the Antilles. To these Prof. Dickie added *R. Ransoni* from Barbadoes. The new species, *R. Andersoni*, differs from the two former in the frond being completely sessile on the mass of rhizoids, and from the latter in the sessile frond being entire. A hitherto unidentified, imperfect specimen brought by Cumming from the East (Philippines?) is now found to be identical with Dr. Anderson's example, which is well preserved in spirit, and thus the Oriental habitat of the genus is corroborated. The author describes minutely and illustrates the remarkable rhizoid filaments of *R. Andersoni*.—A second paper was read by Mr. G. Murray, viz. on two new species of *Lentinus*, one of them growing on a large *Sclerotium*.—Mr. J. G. Baker afterwards gave orally the gist of a communication on a collection of ferns made in North Borneo by the Bishop of Singapore and Sarawak.

Physical Society, February 27.—Dr. J. H. Gladstone in the chair.—Dr. Sydney Young and Mr. D. E. Jones were elected members of the Society.—The following communications were read:—The relations of pressure, temperature, and volume in saturated vapours, by Prof. W. C. Unwin. In the first part of this paper certain formulæ given by Messrs. Ramsay and Young in a recent communication on some thermodynamical relations are criticised. The most important of these is the statement that for different saturated vapours at the same pressure $p\frac{dp}{dt}$ is constant. Prof. Unwin finds, however, that $t\frac{dp}{dt}$ is less constant than $t^2\frac{dp}{dt}$, while $\frac{t^2}{p}\frac{dp}{dt}$ is nearly a constant quantity for all saturated vapours under any conditions. This result suggested that

$$\frac{t^{n+1}}{p}\frac{dp}{dt}$$

might be more nearly constant, and the integration of this gives

$$\log p = a - \frac{b}{t^n},$$

a formula to the examination of which the second part of the paper is devoted. From it may be derived the following relations in which for convenience in calculation the logarithms given are to the base 10.

$$t = \left(\frac{b}{a - \log p}\right)^{\frac{1}{n}}$$

$$\frac{1}{p} \cdot \frac{dp}{dt} = 2{\cdot}3025\,\frac{nb}{t^{n+1}}$$

$$= 2{\cdot}3025\,n\,\frac{(a - \log p)^{\frac{n+1}{n}}}{b^{\frac{1}{n}}}$$

$$\therefore \frac{t}{p} \cdot \frac{dp}{dt} = 2{\cdot}3025\,\frac{nb}{t},$$

&c. These formulæ have been examined in the case of steam from − 30° to 230° C., and with pressures varying from ·4 to 20,000 mm. The constants were found to be

$$a = 7{\cdot}5030 \;\ldots\; b = 7579 \;\ldots\; n = 1{\cdot}25,$$

and the differences between the calculated results and the observations of Regnault and Zeuner rarely exceeded 1 per cent., while generally much smaller. a, b, and n have also been found for some other substances, with the following results:—

Alcohol	$a = 7\cdot448$ ...	$b = 8784$ ...	$n = 1\cdot29$
Ether	$a = 6\cdot9968$ ...	$b = 3047$ ...	$n = 1\cdot153$
Mercury ...	$a = 9\cdot8651$ ...	$b = 597\cdot5$ ...	$n = \cdot69$
Carbonic acid	$a = 8\cdot4625$ ...	$b = 302\cdot8$ ...	$n = \cdot77$

Prof. Perry offered some criticisms upon this paper, and believed that for practical purposes the expressions given would not be found superior to Rankine's formula

$$\log p = a - \frac{b}{t} - \frac{c}{t^2},$$

which gives p in terms of t, and and a quadratic expression for obtaining t in terms of p. He also observed that the chief aim of Ramsay and Young's paper was to obtain relations between the pressure and temperature of different saturated papers, so that the connection between temperature and pressure having been observed and recorded for one vapour, that for any other vapour could be at once deduced from it.—On a map of the world in which the proportion of areas is preserved, by Mr. Walter Baily. The author had devised a method for constructing such a map, but has subsequently found that one precisely similar was employed by Flamsteed in 1729 for charting the stars in his "Atlas Cœlestis." The construction applied to the earth is briefly as follows. Draw a straight line to represent the meridian that is to occupy the centre of the map. Divide this line into equal parts representing upon a convenient scale the distance between the parallels of latitude, and through these points draw a series of lines at right angles to the original line; these are the parallels of latitude. Mark off on these the actual distances at which the meridians cut them; through the points so found the meridians may be filled in, and the map constructed. From the method of construction it is evident that, although the outlines in the map are distorted, the amount of distortion increasing with the distance from the central meridian, the proportionality of areas is preserved, a fact which the author believes will render the map useful for recording rainfall, depth of sea, ocean currents, &c.—On a delicate calorimetric thermometer, by Prof. S. U. Pickering.

EDINBURGH

Royal Society, February 1.—Mr. J. Murray, Vice-President, in the chair.—Several obituary notices were read.—Dr. Thomas Muir read the second part of a paper on the theory of determinants in the historical order of its development.—Mr. G. Brook communicated a paper on the origin and formation of the germinal layers in the Teleostei.—Mr. A. C. Mitchell described the results of experiments on the thermal conductivity of ice. A method involving periodic variation of temperature was used.

February 15.—Mr. R. Gray, Vice-President, in the chair.—Mr. W. Durham read a paper on chemical affinity and solution.—Mr. J. T. Cunningham, of the Scottish Marine Station, read a paper on the reproductive elements of *Myxine glutinosa*.—Dr. J. R. Buist communicated a paper on the life-history of the micro-organisms associated with Variola and Vaccinia.—Mr. A. P. Laurie discussed the probable heats of formation of zinc-copper alloys, as determined by observations on the E.M.F. of constant voltaic cells with the alloys as negative elements. His results indicate the formation of a compound of the formula $CuZn_2$ with an evolution of heat producing a fall of E.M.F. equal to 0·5 volt.—Prof. Tait, in a paper on the mean free paths in a mixture of two systems of spheres, generalised his results as given in previous papers.—Prof. Duns read a paper on two shrunk human heads from South America.

March 1.—Prof. Douglas Maclagan in the chair.—Sir W. Thomson read a paper on the magnitude of the mutual attraction between two pieces of matter at distances of less than 10 micro-millimetres.—Prof. Tait read a paper on a theorem in the science of situation.—Mr. John Aitken communicated a paper on radiation from snow, and also a paper on thermometer screens.—Mr. J. H. Pollok discussed the relation between the volume of an aqueous solution of a salt and the sum of the columns of its constituents.—Mr. W. Peddie read a paper on the increase of electrolytic polarisation with time.

Mathematical Society, March 12.—Mr. W. J. Macdonald in the chair.—Mr. Harry Rainy read a paper on bifilar suspension treated by the method of contour lines, and Mr. J. S. Mackay gave an abstract, with notes, of a paper of Euler's, entitled "Solutio facilis problematum quorumdam geometricorum difficillimorum."—A conversation took place regarding work to be done under the auspices of the Society by groups of members, with the result that investigations were undertaken on linkages, projective geometry, and the bibliography of mathematical periodicals.

PARIS

Academy of Sciences, March 8.—M. Jurien de la Gravière, President, in the chair.—Foundation of a hospital for the treatment of rabies. The following articles have been adopted by the Commission appointed by the Academy to promote this object:—(1) An establishment for the treatment of rabies after the bite of a mad animal shall be founded in Paris under the title of "Institut Pasteur"; (2) this Institute shall admit Frenchmen and foreigners bitten by dogs or other mad animals; (3) a public subscription shall be opened in France and abroad for the foundation of this establishment; (4) the funds thus raised shall be applied under the direction of a Committee appointed for the purpose; (5) subscriptions received by the Bank of France and its branches, the Crédit Foncier and its branches, the Treasury, and public receivers. Names of all subscribers to be inserted in the *Journal Officiel*. Amongst the Committee are the names of MM. Jurien de la Gravière, Pasteur, Bertrand, Vulpian, Marey, Paul Bert, de Freycinet, Magnin (Governor of the Bank of France), Baron Alphonse de Rothschild, and the Perpetual Secretaries of the Academies of Sciences, Inscriptions et Belles Lettres, Beaux Arts, and Moral and Political Sciences.—Determination of the elements of refraction: the most convenient practical solution of the problem, by M. Lœwy. Compared with the older methods here passed in review, the new process enables the observer to obtain in a single month a greater precision than was formerly possible after fifteen years of observations and researches of all sorts required to determine the instrumental constants.—Remarks on the danger of fire arising from the use of nitric acid in the manufacture of certain industrial objects, and especially of explosive substances, such as gun-cotton and dynamite, by M. G. Lechartier. Several instances are mentioned of straw and other organic substances when heated, and even at a low temperature, taking fire by accidental contact with this acid.—Equatorial observations of Brooks's, Barnard's, and Fabry's comets, made at the Observatory of Bordeaux in February 1886, by MM. G. Rayet and Courty.—Observation of the nebula in Maia, by M. Perrotin. In a letter addressed from Nice to M. Mouchez the writer states that by masking Maia he was able distinctly to observe the nebula discovered by MM. Henry, first on February 28, and again, in company with MM. Thollon and Charlois, on March 3 and 4.—On the construction of objectives for instruments of precision, by M. Léon Laurent. The objectives here described and illustrated have been executed by practical methods, which, according to the author, yield the best possible results. They have a diameter of 70 mm. with focus 735 mm.—On the isomeric states of the sesquichloride of chromium: gray hydrated chloride; anhydrous chloride, by M. A. Recoura. The author's researches have led to the determination of two isomeric varieties—a gray chloride and a green chloride, with which latter is connected the violet anhydrous chloride. Dissolved in water, both varieties constitute two extreme states capable of being transformed one into the other by passing through all the intermediate states, the gray-blue solution constituting the stable state of the extended solutions, the green solution the stable state of the highly-concentrated solutions. In another paper it will be shown that these are not the only varieties of chloride.—Note on a combination of methylic alcohol and sulphate of copper, by M. de Forcrand.—On the action of ammonia and water on chloroform, by M. G. André. Some details are given regarding the use of ammonia in aqueous solutions, with indications of the relative proportions of the products resulting from this reaction.—Note on the action of picric acid on terebenthene and on thymene, by M. Lextreit.—On the histogenesis of the elements contained in the ovaries of insects, by M. J. Perez.—On the anatomy of the reproductive organs of Pontobdella (*P. muricata*, Leach), by M. G. Dutilleul.—A contribution to the study of the Miocene palms of Brittany, by M. Louis Crié.—On the distribution of inverted formations in the region of the Jura comprised between Geneva and Poligny, by M. Bourgeat.—Note on a method of direct analysis of rocks by means of their physical properties, by M. Thoulet. The physical properties of which the author avails himself in this process are weight, specific heat, density, and the coefficient of cubic expansion (variation of density with temperature), the two last being easily determined even with small samples by means of the fluid of iodides already recommended by him.—Remarks on M. Mushketoff's orographic and geological description of Turkestan, by M. Daubrée. Of the three volumes of explanatory text to the map of Russian Turkestan (scale 1 : 1,250,000), the first has now appeared. It contains a summary of the explorations of Turkestan from the remotest times down to the year 1884, and a geological description of the Aralo-Caspian steppes, with a small geological map of Turkestan.

BERLIN

Physical Society, January 22.—Dr. König spoke of some photometers he had quite recently tested in respect of their precision. The simple Bunsen photometer, consisting of a screen of fine writing-paper smeared with a grease spot, laboured under the drawback that it was not possible to contemplate simultaneously the two sides it was desired to compare. There were several modifications of this apparatus planned with a view to overcoming this defect. First, there was the application of two mirrors inclined at 45°, by means of which both surfaces were seen in juxtaposition. Other contrivances for the same purpose were the application of a prism, the edge of which lay in the plane of the screen, the use of two prisms, and, further, the use of two totally reflecting prisms with lenses. The last-named description of photometer, as also the mirror-photometer, were very exact, but it now appeared that it was not possible to cause the spot of grease wholly to vanish from view. For such precise photometers there would, on the contrary, have to be found two substances which reflected and transmitted the light differently, but yet absorbed it with equal strength and possessed the same structure. Weber's photometer was constructed according to an entirely different principle. It consisted in the main of a small benzene lamp, which was placed in a tube in front of a mirror and which illumined a milk-glass plate displaceable in the tube. From the illumined milk-glass the light was carried to a totally reflecting prism, and thence into the eye-piece, where it lighted up the half of the field of vision. The other half received light from a milk-glass plate standing in the direction of the eye-piece behind the prism. This milk-glass plate was illumined by the light which was to be measured. In the case of like-coloured light the registrations of the Weber photometer were very exact, but in the case of different-coloured lights such precision was not obtained. Of the means employed by Herr Weber to measure different-coloured lights with his photometer, that which consisted in bringing first a red, then a green, and thereafter a blue glass before the eye-piece, and taking the average of the three measurements, was still at this day the most approximately exact, but was yet inadequate. A great advantage belonging to the Weber photometer, on the other hand, was that by means of it the scattered daylight could be measured. The readily available Weber photometer would prove itself particularly useful for the purpose of testing the conditions of illumination in school-rooms.—Dr. Grunmach reported on the barometric investigations carried out by him in the Normal Gauging Office. He described at length the arrangement of the normal barometer, the vacuum of which was measured in an electrical way. A combination of the barometer-vacuum with a Geissler tube permitted the attenuation to be examined even beyond the limits of the pressures measurable by the cathetometer. The occurrence of the phosphorescence light in the spectral tube was a standard for the highest degrees of attenuation, in which the vacuum was filled with quicksilver vapour of the tension of only 0·01 to 0·02. A still better vacuum would be achieved when the quicksilver vapour was made to be absorbed, a condition which the speaker had in vain tried to effect with selenium. With this barometer was compared a large number of normal barometers according to a method described at large by the speaker, and with the application of the developed formulæ of reduction. Under these comparisons it appeared that the impurity of the free quicksilver-cup heightened the meniscus, and thereby the registrations also of the barometer. In the case of older barometers, a series of other disturbing influences likewise showed themselves, which would have to be further investigated. In the discussion which followed this address, Dr. Goldstein proposed for the electrical measurement of the vacuum, instead of Geissler's spectral tube, the employment of a wide tube which let the fluorescence light pass more obviously into the phenomenon; and for the graduations of these highest degrees of attenuation the thermometer would, he maintained be better adapted than were the optical phenomena. Let, namely, a thermometer be brought into a vacuum-tube whose positive pole was a point, but whose negative electrode was a steel plate nearly filling out the tube in front of the cathode; then the thermometer, when the attenuation reached such a degree that the cathode light appeared would mount 80° to 90° above the temperature of the room. At the positive pole the thermometer rose only about 3°. This rise of temperature in the cathode light occurred in connection with the degree of attenuation, and might be utilised for the measurement of these degrees.

BOOKS AND PAMPHLETS RECEIVED

BOOKS :—"Schriften der Naturforschenden Gesellschaft in Danzig," Neue Folge, Sechsten Bandes, Drittes Heft (Danzig).—"The Construction of Harbours," 3rd edition, by Thos. Stevenson (A. and C. Black).—"Three Years of Arctic Service," 2 vols., by A. W. Greely (Bentley).—"The Quarterly Journal of Microscopical Science," February (Churchill).—"Frictional Electricity," by T. P. Treglohan (Longmans).—"Hand-Book of the History of Philosophy," by E. Belfort Bax (Bell).—"Treatise on Statics," vol. ii., 3rd edition, by J. M. Minchin (Clarendon Press).—"Analisi delle Ipotesi Fisiche," by C. Zanon (Tondelli, Venice).—"Proceedings of the American Academy of Arts and Sciences," May to October 1885 (Wilson, Boston).—"Transactions of the Anthropological Society of Washington," vol. iii.—"Proceedings of the Academy of Natural Sciences of Philadelphia," part 3 (August to December 1885).—Memoirs of the Geological Survey of India: "Palæontologia Indica," ser. x.; "Indian Tertiary and Post-Tertiary Vertebrata," vol. iii. parts 7 and 8; "Siwalik Crocodilia, Lacertilia, and Ophidia, and Tertiary Fishes," by R. Lydekker (Trübner).—"Hong Kong Observatory Reports," May to November 1885.—PAMPHLETS :—"On the Movement Cure in China," by D. J. Macgowan.—"The Present Position of the Museum and Art Galleries of Glasgow, 1886" (Anderson, Glasgow).—"Twenty-ninth Annual Report on Free Public Libraries and Museum of Sheffield."—"Les Crânes dits Déformes," by J. Ignaciode Armes (Havane).—"Cellulose," by C. F. Cross and E. J. Bevan (G. Kenning).—"Separatabdruck aus dem Repertorium der Physik," by Dr. F. Exner.—"The Typhoons of the Chinese Seas in the Year 1885: Essay on the Atmospheric Variations in the Far East during January 1885," by R. P. Marc Dechevrens (Kelly and Walsh, Shanghai).

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