THURSDAY, JUNE 17, 1886

EARTHQUAKES AND OTHER EARTH-MOVEMENTS

Earthquakes and other Earth-Movements. By J. Milne. "International Scientific Series," Vol. LVI. (London: Kegan Paul, Trench, and Co., 1886.)

THE object of this work is "to give a systematic account of various earth-movements": these are classified as (1) Earth-quakes, (2) -Tremors, (3) -Pulsations, and (4) -Oscillations, which are severally defined as (1) sudden or violent, (2) minute, (3) slow, (4) secular movements of the ground. The earthquakes occupy 305 pp., whilst only 43 pp. are given up to the other three motions. After an introduction follows a description (22 pp.) of about twenty different kinds of instruments for recording earth-movements (seismo-scopes, -meters, and -graphs), beginning with an ancient Chinese seismoscope (A.D. 136). The construction of a proper seismo*graph* which shall record period, amplitude, and direction of movements is difficult, the inertia of the moving parts masking the earth-movement. A set of tipping columns seems to be the simplest seismoscope, and some form of pendulum the simplest seismograph: these can be made "astatic," so as to retain any deflected position. Of recorders of motion a smoked-glass plate seems the simplest. The "Gray and Milne seismograph" is an elaborate instrument, recording continuously and simultaneously the times, and also the three rectangular components, of any displacement.

The explanation of earthquake propagation by waves of elastic compression and distortion, shadowed forth by Dr. T. Young, is fully discussed and illustrated for the general reader: the former are compared to sound-waves and the latter to light-waves; unlike these, however, the direct waves travel the quicker. It appears that about seven-eighths of the speed of wave-transit through homogeneous rock is lost in actual rocks as found *in situ*.

Experiments on artificial earthquakes have—as might be expected—been few. Only three sets appear to have been published. Those by Mr. Mallet (published in 1851) were based on explosions of large masses of powder up to 12,000 lbs. Those by General Abbot in America (published in 1876) were based on explosions of from 70 to 400 lbs. of dynamite. Those by Mr. Milne in Japan, since 1880, were based on the fall of a ton weight through from 10 to 35 feet, and on explosions of 1 to 2 lbs. of dynamite. The general conclusions are that the wave-speed is quicker for direct than for transverse vibrations, is quicker through hard than through soft rock, increases with increase of the shock, and decreases with distance. It is clear that opportunities for experiment on the effect of explosions such as the above must often occur, and that a small expenditure on seismographs alone is needed to embrace the opportunities.

There appears to be no known limit to the frequency and duration of earthquakes. Shocks occur continuously in the Andes (p. 246), and have lasted for weeks in New Zealand at the rate of 1000 a day (p. 72). Continuous shaking has been *felt* in Japan during $4\frac{1}{2}$ minutes (p. 73). Recorded vibration-periods vary from two-tenths of a second to one second, and the amplitude may amount to 1 foot without rupture. Some calculations are given of *velocity* of motion of the ground derived from fall of buildings and projection of copings, caps, &c.: these are open to large error from omission of resistance to fracture and of friction. The conclusions as to the rate of earthquake propagation agree with those derived from the artificial earthquakes quoted above.

The most practically useful chapter is that on effects on buildings (a subject recently discussed at the Institution of Civil Engineers), as to which the most important conclusions are—(1) local knowledge alone will guide to the safest site; thus hills, valleys, plains, hard strata, soft strata, &c., are each safe in some, unsafe in other countries. (2) If the direction of shocks be definite, place the blank walls parallel, and the pierced walls perpendicular thereto. (3) Openings at different levels in the same wall to be échelonned. (4) Avoid flat arches, or place wood lintels over them. (5) Avoid heavy copings, caps, &c., and tall chimneys. (5) Use roofs of low pitch. (7) Structures of different vibration-period should not be connected.

Structures of bamboo and timber are seldom injured by earthquake-shock directly; earthquakes are only indirectly destructive to them through fires (caused by the upsetting of lamps) and floods (which sometimes follow).

The earthquake-effects on land are the opening of cracks and fissures, with occasional discharge of water, mud, &c., landslips, and disturbances of lakes, rivers, &c.; also upheavals and depressions of whole tracts: these are —with the exception of the last—seldom extensive. The chief effect on the ocean is the raising of a great sea-wave, sometimes very large, *e.g.* 60 feet high at Lisbon (1761), 80 feet at Callao (1724), 210 feet at Lupatka (1737). These waves are often more destructive on land than the actual shocks; the influx is usually preceded by an outflow, which in fact acts as a warning. One of the most remarkable effects is the distance to which these waves are propagated as "great waves," *e.g.* right across the Pacific. Thus most large earthquakes on the east or west coasts of the Pacific produce waves which are recorded on the opposite coast about twenty-four hours after. From the recorded time of transit of these waves and the known distance the average depth of the ocean (supposed uniform) can be calculated by Russell's formula ($v^2 = gh$); the calculated depths are generally less than the soundings (which err necessarily in excess).

As to source of earthquakes eight methods are given for finding the "epicentrum" or *surface*-origin, and four for finding the "centrum" or *actual* origin, on various assumptions: *e.g.* radiation from a point (viz. the epicentrum), uniform propagation, homogeneous strata, &c. Results depending on such doubtful assumptions can only be very rude approximations.

As to distribution over the world, it appears probable that all parts of the world have been shaken at various times, but that in the historic period the regions most liable to earthquake are those near to active or recently active volcanoes, especially the Pacific border (which actually contains 172 out of a total of 225 now active volcanoes); also earthquakes are propagated chiefly *along* valleys or ridges.

The distribution of earthquakes in time has been much discussed, but no periodic law either secular, seasonal, or diurnal, either for the world in general or for any one place, is very clear.

After discussing the synchronism of earthquakes with numerous physical phenomena (positions of heavenly bodies, states of air, &c.), the causes of earthquakes are considered, and the conclusion is drawn that the primary causes are probably terrestrial, such as (1) sudden cracks consequent on over-stretching of the earth's crust during elevation; (2) explosions of steam; (3) collapse of hollows produced by volcanic ejection and by the continuous solution and removal of matter by springs; (4) change of load over large areas due to rise and fall of the tides and to changes in air-pressure.

As to prediction of earthquakes, nothing certain is yet known. In many cases there are noticeable changes in springs and wells preceding earthquakes. One useful warning is, however, obviously possible, viz. the report of an actual earthquake on one side of the Pacific could be at once telegraphed to the other side, thus giving twenty-four hours' warning of the probable advent of a great sea-wave.

As to earth-tremors, two curious cases are quoted: (1) the extra crowds of people in Greenwich Park on public holidays cause extra shaking in the Greenwich Observatory instruments; (2) certain delicate observations projected at Cambridge in 1880-82 proved futile in consequence of the continuous earth-tremors masking the delicate effects sought. To these might now be added in London the tremors produced by the Underground Railway. Systematic record of earth-tremors (micro-seismography) has now been made in Italy in many towns for ten years: these tremors appear to be periodic, and to be connected with the sun's and moon's motions, and with the state of the barometer, and to increase *before* earthquakes, so that there is some hope of possibility of earthquake prediction from this research.

The phenomena of earth-pulsations and -oscillations quoted are numerous and interesting, but space fails to enumerate them.

The work begins with an earthquake-map, and ends with a list (10 pp.) of earthquake-literature.

This work is well worthy of its place in the International Scientific Series, and may be accepted as a monograph on its subject by an accomplished seismologist, who, from his residence in Japan, has had ample opportunities of studying the actual phenomena.

ALLAN CUNNINGHAM, Major, R.E.

FRICTIONAL ELECTRICITY

Frictional Electricity. By Thomas P. Treglohan. (London: Longmans, Green, and Co., 1886.)

THIS is a little book written for first beginners in the study of electricity. On the whole it is satisfactory; although the writer betrays curious want of knowledge or want of judgment here and there. The diagrams are good, and the descriptions fairly clear; and from place to place instructions are given to teachers as to experiments they may make before elementary classes for the purpose of illustrating and bringing home to the learners the various parts of the subject. The construction of simple pieces of apparatus, such as a boy may make for himself, is also described throughout the book and in a number of paragraphs at the end.

There are, however, certain points to which we take serious exception. First, we cannot regard Mr. Treglohan's mode of looking at inductive phenomena as correct or satisfactory. For example, speaking of the electrophorus, he says:—"If, while the conductor rests upon the excited cake and is under the inductive action of it, the upper surface of the conductor be touched by the finger, the free negative passes to the earth, and an equal quantity of positive enters the disk from the earth." The same statement is made on the following page, so that there is no doubt whatever that the statement about the "equal quantity of positive" is really meant. In the diagrams throughout the book too, where discharge as the result of induction is going on two little arrows are shown, one marked + and the other −, and pointing in dissimilar directions. This seems to us particularising with a vengeance the action of two fluids.

On p. 35, under the heading "specific inductive capacity," we are told that "It was established by Prof. Faraday that, for an excited body to act upon a conductor by induction, some substance must exist between the two through which the electricity may be imparted." Shade of Faraday!

At the end of this paragraph, speaking of specific inductive capacity, we are told that "dry air is superior to moist air in this respect." We do not think that any difference has been proved to exist between dry air and moist air, either as to induction or as to conduction; though there is a common misapprehension (shared by the present author, p. 30) of a difference as to this latter quality.

The use of the condensing electroscope seems to be misunderstood by the author. It cannot be used in the way described for testing "lightly charged bodies." Its main use is for testing a weak but continuous source.

There is also an extraordinary paragraph about a white-hot iron ball on p. 107, for which the author seems to make Prof. Guthrie responsible, and in which the experimenter is told to put a white-hot iron ball on the electroscope in order to prove certain statements! We fear the experimenter will not obtain much valuable information from the experiment; and it is *not true* that, with respect to the supposed indifference of a white-hot body to electrification, "in this it resembles the indifference to magnetism of a white-hot iron ball."

A few misprints we have also noticed. Sir William Thomson's name should be spelled without a "p"; iodine and starch paper is coloured blue, not brown, by ozone. Putting aside these defects, however, this little book will probably be found useful to teachers for the elementary stage in the Science and Art Department, for whose benefit, as we are told in the preface, it has been compiled.

J. T. B.

OUR BOOK SHELF

The Gallery of Marianne North's Paintings of Plants and their Homes, Royal Gardens, Kew. Descriptive Catalogue compiled by W. Botting Hemsley, A.L.S. Fourth Edition. Pp. 160. (London: Printed under the Superintendence of Her Majesty's Stationery Office, and sold at Kew Gardens, 1886.)

THIS is a much enlarged and improved edition of the previous excellent catalogue of these valuable and interesting paintings. The whole collection having been rearranged and as many as 220 additional paintings added, the value of the catalogue, as may be supposed, is considerably enhanced, and the more so as many of the new paintings are the result of Miss North's more recent travels in such noteworthy countries as the Seychelles. The description of each of the pictures, with notes on the habits and uses of the plants represented, are both interesting and useful, the whole being carefully condensed within reasonable compass, but beyond this the present edition is made doubly useful by the addition of a most carefully drawn up list of plants referred to in the catalogue, arranged alphabetically under their natural orders, together with the native country of each species. The sketch of the "general features of the vegetation of the countries visited" is a most valuable addition, each country being treated of separately. These are, as Mr. Hemsley says, "short paragraphs describing the prominent features and peculiarities of the vegetation of the various countries whose floras are illustrated with some degree of fulness therein." Thus, under Chili we have first a general description of its position, character, climate, and meteorological conditions, followed by notes on the vegetation, with references to the more important genera. This part of the book, which forms the introduction, and extends to thirty-one pages, will be extremely useful to all students of geographical botany; indeed the whole book has a value besides that of a mere "guide" to the visitor to the gallery.

We cannot conclude our brief notice of this excellent catalogue without referring to another important feature in this edition, namely, the introduction of a really good map of the world, showing in red the countries visited by Miss North, and in green other floras partially illustrated in the collection.

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.*]

The Thomson Effect

IT affords me much satisfaction to find that my statement of the facts of the Thomson effect is in the main accepted by Prof. Tait. The errors to which I called attention had been copied into at least one recent electrical text-book, and were in a fair way to obtain general recognition as fundamental principles.

The only objection which Prof. Tait raises to my statement is my omission to include a correction for the variability of one of the coefficients with temperature. This is no valid objection, as the limits of space forbade me to encumber my explanation with any unnecessary detail, and my mathematical investigation was avowedly only approximate. The correction thus supplied by Prof. Tait and embodied in his equation (1) is to the effect that, in flowing through a copper conductor, the electric current, while displacing the whole temperature curve in the forward direction (as stated by me), displaces the maxima more than the minima, so as to make the descending gradients steeper and the ascending gradients less steep, the displacement of each point being proportional to its absolute temperature. In iron the same rule holds except that "backward" must be substituted for "forward." Prof. Tait agrees with me that the ordinates are not increased or diminished, but are simply shifted. The current does not tend to diminish the difference between maxima and minima, as a real fluid would do.

The phrases "electric convection of heat" and "specific heat of electricity" have served their purpose, as provisional terms, furnishing a short and easily-remembered way of expressing certain new facts, which would have required for their full expression a long periphrasis; but to retain them any longer in our text-books is to place a needless stumbling-block in the way of teachers and students.

Let Thomson's coefficient σ (hitherto called the specific heat of electricity) be called the *Thomson coefficient*, and let the numbers tabulated by Prof. Tait under the heading "Specific Heat of Electricity" ("Heat," p. 180) be called *tangents of slope*, a name which speaks for itself when the meaning of a thermo-electric diagram is understood. The Thomson coefficient will thus (in the ordinary case) be equal to the absolute temperature multiplied by the tangent of the slope; and the amount of the Thomson effect between two given temperatures will be their difference multiplied by the Thomson coefficient for the mean temperature.

A good name is wanted for the ordinate of any point in a thermo-electric diagram. In the first edition of "Units and Physical Constants," being driven to give it some name, and not being able to think of a good one, I employed the makeshift term, "thermo-electric value." In the forthcoming edition I propose to denote it by the more appropriate name, "thermo-electric height." J. D. EVERETT

Belfast, June 12

Black Rain

THE heaviest shower on record fell yesterday afternoon between 6 and 7 p.m. It began at 6.36, and almost six-tenths of an inch fell in the first quarter of an hour. The wind was shifting rapidly at the time from north through west to south. The water collected was very dark, but not so black as that which fell on April 26, 1884. S. J. PERRY

Stonyhurst Observatory, June 10

Meteor

YESTERDAY (Sunday), June 13, at 10.12 p.m., looking eastward, I saw a magnificent meteor, extremely brilliant, darting from southward to northward, at an altitude of about 30°. It must have been a minute or two in view, as I had time to stop walking and watch it describe a long track. When it had passed the prime vertical it burst into a shower of sparks which, falling in a second or two, became invisible. The colour of the meteor was intense white, with a bluish tinge in rear, and only a very slight trail was visible. On exploding the light was crimson for an instant, and the sparks were red.

Should you receive any other notices of this meteor, its height, distance, and magnitude may be computed. It seemed to me of the diameter of a cricket-ball. I have never seen so large a meteor before, or any describe so long a path. The memorable meteor-shower of 1866 (?) exhibited none so large, though possibly many had longer tracks. You may hear of it from the North Sea. R. STRACHAN

11, Offord Road, London, N., June 14

"Arithmetic for Schools"

MR. LOCK is a little loose, not to say unfair, in the drawing of his inferences; I prefer, therefore, to stand by my own words.

(1) When I said "the purely arithmetical part" (not Part) of the book, I meant what I said, viz. those sections where such *theoretical* matters as the finding of the highest common factor, the extraction of the square root, &c., are treated of. The possibility of any reader of NATURE drawing the inference which Mr. Lock succeeds in drawing, viz. that the book is expressly divided into Pure Arithmetic and Practical Arithmetic, is surely a very trivial matter.

(2) At p. 181 the following definition occurs:—"Rate of interest is the ratio of interest to the principal." This I gave as an instance of "slight inaccuracy." It may be a fundamental misconception, and not a slight inaccuracy; but if so Mr. Lock

has no cause for complaint. He ought to know that interest is a function of two variables.

(3) In reply to Mr. Lock's request for other slight inaccuracies I might ask, without leaving the subject of interest, what under the sun "inverse interest" is: but though inaccuracies of language are not desirable in a school-book, I prefer to draw his attention to more important matters. Every arithmetician knows that the practical questions which come under such headings as Simple and Compound Interest, Exchange, Discount, Stocks, &c., are not questions of a different kind *arithmetically*, being all so-called "proportion" questions, and that no more important fact can be taught to the student of arithmetic regarding them. Now here is Mr. Lock's treatment. Simple and compound proportion questions are put under the headings "Problems" and "Complex Problems"—names, by the way, quite illogically chosen and not consistently adhered to. Exchange is tacked on to Complex Problems by the words, "examples in Exchange can be worked by the above method"—indeed, these words and a worked example constitute the sum total of information given in the book on this subject. No one could object to the union here indicated, but surely the same is equally true of several of the other subjects. After Exchange comes a section headed "On Problems concerning Time: I., Time and Distance." These are not problems in the sense previously specified, but belong to the genus of examination questions which concern bodies moving in the same path with different speeds. A like remark applies to the section which follows, headed "II., Time and Work." Late in the day, after Interest, Discount, &c., there appears a chapter "On the Use of the Term *Per Cent.*" So far as it is on anything (for it consists of seven or eight lines of introduction, three worked and forty-five unworked examples), it is on the calculation of rates of gain and loss. Now all this, one is bound to affirm, is strangely illogical, and tends to give a most erroneous conception of arithmetic as applied to practical affairs. I used the expression "slight inaccuracies of thought" in referring to such a mode of treatment, because it was impossible to be more severe without going into detail, and because it seemed imperative to say something against a practice, which our examination system fosters, of forming text-books by collecting all the kinds of exercises met with in examination papers and separating them into carelessly ticketed groups prefaced by a definition or two. The purely arithmetical, and larger, part of Mr. Lock's book is not of this character, and is, especially as regards the definitions, very carefully prepared; he would considerably enhance the value of the whole by wisely modifying the rest in the second edition. THE REVIEWER

I THANK you for your courtesy in permitting me to see the reply of your reviewer to my letter which appeared in NATURE of June 3 (p. 100). That my letter was written under very exceptional circumstances will be clear to any one who will take the trouble of comparing your reviewer's defence of his criticism with the book itself. I will, however, with your permission, make one or two comments on his reply.

(1) That a wrong inference was suggested by the words of the reviewer is, no doubt, of little consequence, except that it afforded me a ground for an appeal to you for further information.

(2) Your reviewer did not quote in his review, as he now does, my definition of rate of interest; he asked whether rate of interest is totally independent of the time, implying that I stated that it was so, and ignoring the fact that the manner in which time is involved in Interest (not in *rate* of interest, on which point your reviewer seems a little confused) is gradually explained in the next few pages. Might I ask your eviewer whether in Compound Interest the Interest varies simply as the Time?

(3) In his third paragraph your reviewer gives his answer to my request that he should quote *verbatim* the other instances on which he based his unfavourable criticism. There is little or nothing here for me to answer, except that I am compelled, in justice to myself, to point out the reviewer's own mistakes. (i.) He suggests that Exchange ought logically to be placed between Compound Interest and Discount. It would seem necessary to remind him that in questions on Exchange there is no reference to *time*, and that it is the peculiar manner in which time is involved, which distinguishes Interest and Discount from other Problems involving money. (ii.) He states that questions which I have called "Problems concerning Time" are improperly so-called. It will be clear to any one who reads the chapter on "Problems" that a Problem is a question on Variation; so that problems concerning time are exactly what their name indicates. But (even supposing your reviewer were right on these two points) in charging me with being strangely illogical as regards the order of my chapters, he must have overlooked the fact that in the preface I expressly state that "novelty in arrangement has been avoided as much as possible," but that "the order in which his chapters are taken may be varied at the discretion of the teacher." For my part I think that the established order of subjects is not to be lightly upset, certainly not without more sound and weighty reasons than those adduced by your reviewer.

But besides this your reviewer draws an unfair inference, due I suppose, to mere carelessness. The words "Inverse Interest" appear only as the heading of pp. 187, 188, and are obviously an abbreviation for convenience of printing of the words on p. 186, "Inverse questions on Interest." As far, however, as I can understand the general effect of your reviewer's explanation, his objection to my book seems to be this—that it fails to bring into sufficient prominence the fact that the Practical Applications of Arithmetic (which, in accordance with established custom, I have collected under the heads of Exchange, Problems concerning Time, Interest, Proportional Part, &c.), really present the same idea under different circumstances, expressed in different language. I entirely agree with him as to the importance of this fact, and endeavoured, as far as the scope and object of my book would allow, to give it due prominence. For example, for this reason, it seemed unnecessary in Exchange and in the chapter on Profit and Loss to give more than a few words of explanation in addition to the examples worked out. JOHN B. LOCK

Gonville and Caius College, June 14

PASTEUR'S RESEARCHES

IN the current number of the Royal Agricultural Society's *Journal* (vol. xxi. part 1) is a full and able account of the work of the great French experimenter from an agricultural and veterinary point of view, by Dr. George Fleming. The development of Pasteur's genius is traced from his early chemical researches on dextro- and lævo-tartrates to fermentations in milk and in malt. The combination of microscopic with chemical modes of investigation led him to the definite determination of the part played by living organisms in acetic, butyric, and alcoholic fermentations. In these inquiries his own labours were almost entirely original, but it must not be forgotten that a few microscopists in England and many in Germany were working on the same lines, and contributed to the establishment of the modern doctrine that fermentation and putrefaction are both processes dependent on the presence and growth of minute parasitic plants. Pasteur's experimental investigations led him in two directions—in one to the establishment of the now accepted theory of biogenesis: that every living thing is the product of a living parent; in the other to the practical application of the facts ascertained to the manufacture of vinegar and the process of brewing.

Ingenuity in devising experiments and patience in carrying them to a successful issue belong more or less to every successful investigator, but the union in addition of clear theoretical conceptions with skill in the useful application of results is characteristic of Pasteur as it was of Faraday and a few other of the highest intellects.

His investigation into the cause of *pébrine*, or silkworm disease, was undertaken against his will, in deference to the urgency of the eminent chemist Dumas. Pasteur wished to return to his original department of chemistry, and it is remarkable that having once left it he has been drawn further and further into biological researches, while Dumas, who began with valuable work on the development of the ovum, was diverted to chemistry and there made his enduring reputation. Perhaps no instance more remarkable than Pasteur's work on the *pébrine* can be cited of the value of science in a commercial and national point of view. A great industry was all but extinguished, and the impending catastrophe became a question for parliaments and statesmen. A scientific investigator was appealed to; he set to work in 1865, and after four years' continued application he had solved the problem, and delivered his country from the incubus on her industry. It has been well said that Jenner by his discovery of vaccination saved more lives than Napoleon ever destroyed; so Pasteur saved France in 1869 from a far greater tribute than the Prussian conqueror imposed on her in the following year.

This brilliant success, which could be neither concealed nor depreciated, led to the successful experimenter (barely recovered from an attack of paralysis, which ended his last laborious research) being called on to devise a means of checking the ravages of splenic fever (*anthrax*) among horses and cattle. Dr. Fleming gives an interest-account of this terrible scourge, and explains the methods adopted by Pasteur to investigate it. He discovered a method by which its virus may be "attenuated," and thus used for protective inoculation in the same way as vaccination protects against small-pox. This method, though often successful, has not proved uniformly so, and more must be done before its general efficiency is established. Dr. Fleming refers to the results in Algeria, in Prussia, and in Hungary, and to these he might have added those obtained by Dr. Roy in Buenos Ayres.

On the other hand, the treatment by inoculation of a contagious disease among poultry (ill-named *choléra des poules*), a method which was also discovered by Pasteur, appears to be uniformly successful.

The last investigation of the great French experimenter is that upon hydrophobia, which the world is still anxiously watching. This also is described by Dr. Fleming. We have kept our readers informed of the progress of this vast practical trial of a scientific mode of treatment on the victims of a hopeless malady. Every month brings fresh accumulation of evidence on the subject, and we hope soon to have the report of the Commission sent from this country to ascertain M. Pasteur's precise methods and their results. If he should be honoured to be an instrument in the hands of Providence for averting one of the most shocking and terrible diseases to which mankind is subject, the name of Pasteur will live as one of the greatest benefactors of our race. But in any case his work already achieved and its results established form an ample title to the admiration and the reverence of all who can estimate genius or value its conscientious devotion to the service of mankind.

LYCOPODS[1]

THE attention of the readers of NATURE has already been directed towards recent work on the Lycopodiaceæ by the publication of a *résumé* of the researches of Dr. M. Treub, Director of the Botanic Gardens of Buitenzorg, Java. He is the first botanist who has succeeded in giving a connected account of the prothallus, sexual organs, and development of the embryo of any species of Lycopodium, and now his first paper, which dealt with *L. cernuum*, has been rapidly followed by a still more complete and successful study of *L. Phlegmaria*, L. It might be expected that the second paper would be in great measure a repetition of the first, but this is not so; and it may be regarded as one of the most interesting results of this very suggestive and luminous investigation that it brings into prominence the greatness of the possible differences in development of two plants which have hitherto passed, and will continue to pass, under the same generic name. The observations detailed in this second paper are so important in their bearings on our views regarding other allied forms that it is desirable that at least the more striking points should be recorded here.

[1] "Études sur les Lycopodiacées," par M. Treub. Part II. *Annales du Jardin Botanique de Buitenzorg*, vol. v. 2ième partie.

Attempts to germinate the spores of *Lycopodium Phlegmaria* were at first unsuccessful, but after more than a year young plants were found on one of the tree trunks on which spores had been sown, and subsequently similar young seedlings were found in large numbers in the forest. The germination of the spores appears to be slow, and Dr. Treub is of opinion that the culture of prothalli from spores will never be easy, a view which is supported by the fact that the oophore is capable of various modes of asexual multiplication; indeed it appears that the majority of the prothalli found owed their origin to this source, and not directly to the germination of spores. An autonomous existence of the prothallus, independent of the formation of sexual organs, has been demonstrated by Goebel in the case of *Gymnogramme leptophylla*, and a similar, but still more pronounced condition is found in this Lycopod. The prothallus grows in the dead external layers of the bark of trees; it is as a rule devoid of chlorophyll, and consists of cylindrical branches, covered with absorbing hairs. These cylindrical organs branch monopodially, the branches being usually formed in acropetal order; they have a terminal growth with two initial cells, each of which gives rise to half of the cylindrical organ. It is worthy of note that there is a great similarity between the structure of this apical meristem and that of the stem of the sporophore. In the fully-differentiated parts of the prothallus a peripheral tissue one layer of cells in thickness may be distinguished; this gives rise to the rhizoids. The mass of tissue inclosed by this superficial layer, though it shows some slight varieties according to the mode of development of the branch, never attains any high state of differentiation.

The lateral branches, which are not very numerous, take their origin from the peripheral layer, several cells taking part in the formation of each. The growth of these branches may be long-continued, and it is not arrested on the formation of an embryo on another branch. By progressive rotting of the older parts branches may be separated from one another, and this constitutes the simplest mode of increase in number of individuals But, besides this, two other modes of vegetative propagation are known—(*a*) by ordinary propagating organs: these are small ovoid multicellular bodies, which originate from single superficial cells, and are set free by rupture of their pedicels; (*b*) by thick-walled organs, smaller than the above, which only appear on weakly prothalli: these may undergo a period of rest. Among the vascular Cryptogams the only organs hitherto known of a similar nature to these are those described by Cramer; Dr. Treub is, however, of opinion that a truer comparison may be be made to the gemmæ of the Hepaticæ, and especially of *Blasia*, while in many of their general characters, which may be recognised on inspection of the twenty beautiful plates, the prothalli of *L. Phlegmaria* show points in common with the oophore of certain of the Muscineæ.

The sexual organs of *L. Phlegmaria* are produced on the upper surface of the prothallus, and are always accompanied by paraphyses, structures which are absent in other Vascular Cryptogams, but frequently present in the Muscineæ. The position of the antheridia is variable; sometimes they are scattered singly on the vegetative branches, sometimes they are associated in groups, and are then often borne on the considerably thickened extremities of branches. Their development is similar to those of *L. cernuum*, while the antherozoids have two cilia, and resemble those of *Selaginella*. The archegonia have a more definite position, and they appear subsequently to the antheridia, on those thickened extremities of branches which have already borne antheridia: they project from the surface of the prothallus, and have three to five canal cells, while the highest number hitherto recognised among Vascular Cryptogams is three; this is again a point in common with certain Muscineæ.

This would not be the place to enter upon those details of the mode of development of the embryo, which Dr. Treub has worked out with such signal success It must suffice, while referring those who are specially interested in the subject to the original paper, to state merely the most prominent facts. In the first place there is a considerable difference between the development of the embryo in *L. cernuum*, and that of *L. Phlegmaria*, while in certain points the latter corresponds to *Selaginella Martensii*. Thus the ovum in *L. Phlegmaria* divides first by a wall perpendicular to the axis of the archegonium into two: of these, the cell next the neck becomes the suspensor, the other is the mother-cell of the embryo; the latter develops ultimately into a multicellular mass arranged in two tiers: the lower tier forms only the massive "foot," while from the upper (*i.e.* that further from the neck of the archegonium) are derived the stem and single cotyledon, and ultimately also the first root. The mode of origin of the root is interesting in connection with my own recent observations of the exogenous origin of the root in Phylloglossum. According to Dr. Treub's observations, the first root of *L. Phlegmaria* is at first covered by an envelope a single layer of cells in thickness, which cannot rightly be regarded as the outermost layer of the root-cap; accordingly we have the barest possible example of endogenous formation, only a step removed from the exogenous. These and other results of the investigation of the development of the embryo of *L. Phlegmaria* afford fresh material of the greatest value for comparison, not only with other groups of the Vascular Cryptogams and with the Muscineæ, but also with other species of the genus Lycopodium. Further, the full account given of the prothallus provokes a comparison which Dr. Treub has embodied as follows (p. 88):—"As far as it is possible to judge at present, we find in the sexual generation of the Lycopods, more clearly than elsewhere, transitional terms between the great series of the Muscineæ and that of the Vascular Cryptogams." Some readers will doubtless call to mind, in connection with this, a striking passage by a well-known botanist, Prof. Goebel, written a few years ago (Schenck's *Handbuch der Botanik*, Bd. ii. p. 401), which runs thus:—"We must then satisfy ourselves by asserting that the gulf between the Mosses and Pteridophyta is the deepest that we know in the vegetable kingdom, and bridging it over by hypotheses and explanations does not make it one whit the less."

In this treatise of Dr. Treub we are put in possession of those positive observations which, beyond their intrinsic and independent interest, acquire the highest possible value from the fact that they fit into this wide and deep gulf, and materially help to fill it up. Such observations, and the theoretical considerations which follow them, are sure of a hearty welcome among the fellow-countrymen of Charles Darwin.

I cannot close this article without a brief reference to the peculiar case of symbiosis found in the prothalli of *L. Phlegmaria*. Endophytic Fungi have already been described in prothalli of other species, and here Dr. Treub finds the tissues constantly infested by a fungus, apparently one of the Peronosporeæ. Its thin filaments inhabit the interior of the cells themselves, but without killing them, the nuclei of the cells remaining normal, while the growth of the prothallus does not appear to be visibly hindered by its presence. It would appear that we have here a case of "commensal" symbiosis, in the strictly literal sense; unfortunately it is impossible as yet to follow out the subject thoroughly into its details, but we may hope that Dr. Treub may be able shortly to give us some more general insight into the economic relations of the two organisms thus amicably associated together.

F. O. BOWER

THE UNITED STATES FISHERIES[1]

THESE two volumes, with the familiar black cloth binding, shiny paper, and plates of photo-engravings, characteristic of American official publications, are the first instalment of a series, which is to contain the results of an exhaustive survey of the United States fisheries from all possible points of view. The purpose and method of the survey, and the history of its origin and progress, are sketched in a prefatory note by Mr. Spencer F. Baird. In 1879 it was arranged that the Tenth Census, which is under the direction of General Francis A. Walker, should co-operate with the Commission of Fish and Fisheries in carrying out an historical and statistical investigation of the fishery industries. The direction of the whole survey was intrusted to Mr. G. Brown Goode, Assistant Director of the National Museum, who had for some years previously devoted a large portion of his time and energies to the study of the fisheries. The work to be carried out was divided by Mr. Brown Goode into seven departments:—(1) Natural history of aquatic products; (2) the fishing grounds; (3) the fishermen and fishing towns; (4) apparatus and methods of capture; (5) products of fisheries; (6) preparation and manufacture of fishery products; (7) economy of the fisheries. The co-operation of every person who had any special knowledge of the subjects under consideration was secured. The field-work was so divided that each portion could be assigned to men who were most competent from their previous experience to undertake it. The shad and alewife fisheries, for example, were assigned to Colonel Marshall MacDonald, the Alaska fisheries to Dr. T. H. Bean.

It was understood from the beginning that the results obtained should be set forth in a series of finished reports, of which those referring principally to the exploited organisms, namely, fish and aquatic animals, should be presented to and published by the Fish Commission, while those dealing with the exploiting organisms, the fishermen and manufacturers, should be the property of the Census Office. The expenses of the work have been shared between the Commission and the Census. The reports prepared for the Fish Commission being too bulky for publication in the annual reports, permission was obtained from the Senate and House of Representatives to publish them separately. The series will be as follows:—Section i. natural history of useful aquatic animals (the two volumes now before us); ii. the fishing grounds; iii. the fishing towns; iv. the fishermen; v. the apparatus of the fisheries and the fishing vessels and boats; vi. the fishery industries; vii. the preparation of fishery products; viii. fish culture and fishery legislation; ix. statistics of production, exportation, and importation; x. the whale fishery; xi. a catalogue of the useful and injurious aquatic animals and plants of North America: xii. a list of books and papers relating to the fisheries of the United States; xiiii. a general review of the fisheries, with a statistical summary.

The statistical reports prepared for the Census Office are ten in number. The results they contain have been already partially published in Census bulletins and in statistical tables scattered here and there in various volumes. The prefatory note concludes with a brief summary of the statistics of the fisheries. In 1880 the number of persons employed in fishery industries was 132,426, of whom 101,684 were fishermen. The total value of the capital invested was $37,955,349.

After the prefatory note we find the letter of transmittal from Mr. Brown Goode to Prof. Baird. In this it is stated that the work is intended especially for the use of the reading public, and technical zoological discussions

[1] "The Natural History of Useful Aquatic Animals of the United States," forming Section i. of "Fisheries and Fishery Industries of the United States." 1 vol. Text; 1 vol Plates. 4to. (Washington, Government Printing Office, 1884.)

and descriptions have not therefore been included. On another fly-leaf is a list of the authors who have had a share in the production of the work. The number of these is no less than twenty, and among them are such familiar names as Tarleton H. Bean, John A. Ryder, and R. Edward Earll.

The work is divided into five parts: i. mammals; ii. reptiles and batrachians; iii. fishes; iv. mollusks; v. crustaceans, worms, radiates, and sponges. Of the mammals the whales and porpoises are described by G. Brown Goode; seals and walruses, by Joel A. Allen, and Henry W. Elliott, who contributes a chapter on the life-history of the fur-seal; manatees and the Arctic sea-cow, by Frederic W. True. The reptiles and batrachians are also treated by Mr. True. Mr. Brown Goode is responsible for the greater part of the portion dealing with the fishes. The part on mollusks consists of two chapters, one on mollusks in general, by Ernest Ingersoll; one on the oyster, by John A. Ryder. Part V. is the work of Richard Rathbun.

The work of Mr. Brown Goode is always lucid, systematic, and complete. In his account of the whales and porpoises he does not give technical zoological diagnoses, these being, as we have already mentioned, intentionally omitted throughout the work, but he gives the accepted name with its authorities accurately indicated. He describes fully, with references to all the literature of the subject, the distribution, habits, food, and reproduction of all the species having an economic value. Figures of nearly all the species are given; these are taken from various sources, some prepared specially for the present work, some copied from the plates of existing zoological memoirs.

A discrepancy occurs between the title of one of the figures and the description contained in the text: the porpoise sperm whale is stated to have been described by Prof. Gill, under the name *Kogia Floweri*, while the figure given is entitled *Kogia Goodei*, True, the pygmy sperm whale. Two sketches illustrating the whale fishery are reproduced in Plates 3 and 10. The account of the "right whales" is not altogether clear. It takes some time to find out that the species generally known as the "right whale" is *Balæna mysticetus*, L., which is the Arctic whale, or bowhead; while the true right whale is Eubalæna, Cope: but the assertion that *Eubalæna cisarctica*, Cope, is not remotely related to *Eubalæna biscayensis* of the Eastern Atlantic, remains a puzzle.

Mr. Allen's work on the seals is thoroughly satisfactory, and the history of the fur-seal at the Pribylov Islands, given by Mr. Elliott, contains the results of accurate personal observation, which has at last elucidated the meaning of the peculiar and long-known habits of this species. The movements of *Callorhinus ursinus* when absent from its breeding places remain for the present obscure, but the reason why it seeks its breeding places so regularly, and the facts of its reproduction—knowledge of which is necessary in order that a permanent diminution of the numbers of the animal may be avoided—are clearly set forth in this essay.

The illustrations of the account of the seals and of Mr. Elliott's essay are particularly good. Among the former are two maps of the world, showing at a glance the geographical distribution of the useful seals. Mr. Elliott's original sketches of the fur-seal at home in the Pribylov Islands are very spirited and interesting.

Mr. True gives an account of the South American manatee, and reviews lucidly the history of the extinct Rhytina of Behring's Strait.

The chapter on the reptiles and amphibians is entirely unillustrated, for what reason does not appear. The reptiles which afford products useful to man are the alligator, the turtles and tortoises, and one frog—*Rana catesbiana*, Shaw—the bull-frog. This last animal is cultivated in several localities, the eating of the hind-legs being common in most towns of the States.

The note at the commencement of Part III. on the food-fishes is a little inconsistent. "We anticipate the criticism that the book is of no use in identifying the different kinds of fish, by the statement that we expressly desire that it shall not be," is one sentence; and another is, "Most of our important species can be identified by reference to the plates." What the writer evidently means to say is that each species mentioned is accurately figured and receives its correct technical name, so that any one interested in fishes can find out the zoological name of his specimens from the plates, and can read all about range and economical uses, while for more detailed scientific treatment reference must be made to speciegraphical works in ichthyology. Various ichthyologists have contributed to this portion of the work. The fishes of the Pacific coast are the special province of David S. Jordan, while one or two species, like the Californian salmon and the carp, have been allotted to pisciculturists specially familiar with them. Many vexed questions in the biology of fishes are discussed by Mr. Brown Goode with his usual lucidity and comprehensiveness. The pages on the reproduction of the eel, for example, are very interesting reading, and this is by no means a solitary example. The food-fishes naturally take up a large portion of the whole work. They occupy more than half of the volume of text, extending to more than 500 pages. In the plates there is one feature which we have after serious efforts completely failed to understand. On nearly every plate there is a straight line below each figure, apparently intended as some standard of measurement; but the meaning of these lines is not explained.

In his chapter on the mollusks Mr. Ingersoll has not always observed the rule strictly followed in the rest of the work of giving the authority for each specific name used. He gives an account of the distribution of the numerous other species of Lamellibranchs used as food in the United States, but gives no description of oyster-beds. In Mr. Ryder's account of the life-history of the oyster there is a great deal of interesting detail about anatomy and development, and about the writer's own experiments in oyster-culture, but a general account of the distribution of *Ostrea virginica* is wanting. This is a surprising omission, and one much to be regretted.

Why Mr. Rathbun, even in a work intended for general readers, should unite together Echinoderms and Cœlenterates as Radiates is a question which it would be difficult to answer. The name Radiata would require to be considered in a history of zoology, but it is impossible to justify its use in the classification of animals for any purpose in the present state of science. But this and the other slight defects we have pointed out do not make a very great reduction in the value and completeness of the whole work. The labour spent in its preparation has been very great, and the result is a lasting monument to the industry and scientific capacity of Mr. Browne Goode and his numerous fellow workers.

REMARKS ON THE EGGS OF BRITISH MARINE FISHES[1]

THE majority of marine fishes, in regard to reproduction, readily range themselves into certain groups according to the condition of the eggs on deposition. Thus (*a*) a considerable number have delicate pelagic ova, which are generally separate, though in the frog-fish, for instance, they form gelatinous masses. (*b*) Others are characterised by the deposition of thick-walled ova, connected together in more or less firm masses, on or near the bottom, or in special nests. (*c*) A third group is distinguished by laying ova which have filamentous processes or adhesive surfaces for attachment to foreign structures; and some place them in brood-pouches of the males, in which case, however, the capsules appear to be

[1] By Prof. McIntosh, F.R.S., &c., St. Andrews Marine Laboratory.

more delicate. (*d*) A fourth series have their large eggs enveloped in dense horny capsules, which either are fixed by their twisted filaments to marine bodies or find sufficient protection on the extensive sandy flats where they are deposited. (*e*) Finally, a few produce living young, this condition ranging from the well-marked ovo-viviparous *Zoarces* to the even more complex state in the sharks.

It would seem, as far as present observations go, that in those fishes which shed their eggs on the bottom, or in brood-pouches, the ova are matured simultaneously in the ovaries, so that the act of deposition is performed rapidly. This is exemplified in the *Cotti*, in *Agonus* (*Aspidophorus*), *Cyclopterus*, *Liparis*, the herring, and others. In the case of fishes with pelagic ova, on the other hand, the ovaries mature and shed their contents at intervals, so that the process of spawning occupies a period of greater or less duration.

There is little difficulty in the case of the pelagic ova of our shores, such as those of the cod, haddock, whiting, bib, ling, rockling, gurnard, and others in artificially impregnating and hatching them, even from fishes that have been dead for some hours. The mortality, however, from excessive cold and heat is very considerable in a marine laboratory, since the limited quantities of sea-water contained in vessels a foot or even a yard or two across are much more subject to such influences than the vast body of water in the sea. It has to be borne in mind also that the sea-water usually employed in such researches is shore-water, and liable to considerable contamination from the estuaries of rivers and streams—besides other impurities. The difference, indeed, between such water and that of the open sea was illustrated in 1884 (NATURE, vol. xxxi. p. 536), when the pelagic ova of the cod could be more successfully hatched in the large glass vessels ("drop" bottles) in which they were conveyed from the fishing-ground without change, than in the ordinary water dipped from the shore and frequently renewed. In like manner eggs of plaice fertilised on the same ground this year (for which I have to thank Capt. Burn, of St. Andrews) were conveyed quite safely, even after a week's vicissitudes in a stoneware jar amongst sea-water—lightly tied over with "cheese" cloth. During the late winter ova of various kinds suffered severely, however, and the effects of such changes of temperature on the embryos were even more pronounced.

The first series of eggs of the haddock were fertilised on the 15th, and the second on the 16th of February, but the rigorous weather proved ultimately fatal to both. The earlier stages proceeded satisfactorily, but the water in the vessels by and by was frozen on the surface —softish flakes of ice forming a thick coating—on which many of the ova were elevated. No sooner was this ice broken than all or almost all the ova were observed to present the whitish patch and sink to the bottom. Some of those which had floated in mid-water or under the trickle from the supply-pipe escaped destruction, but in a few days they also succumbed after a night of unusual severity, and after the embryos had been outlined. On the other hand, a few ova carelessly thrown at the same period into a small vessel of sea-water in the window of a library escaped injury and developed quickly, though the water remained unchanged.

In the sea the danger from such extreme cold would be minimised, since these pelagic eggs in winter and spring do not float quite at the surface, but always some distance beneath it.

Under the same circumstances in the laboratory the intense frost proved fatal to many adult viviparous blennies and Montagu's suckers, though only the surface of the sea-water in the large glass vessels was coated with the softish flakes of ice. The fluid in the ovaries of the pregnant examples of the former was frozen into a solid mass, as was also the liquid in the urinary bladder, yet the animals were surrounded in all cases by sea-water.

In the Report to H.M. Trawling Commissioners in 1884 reference was made to the statement by Alex. Agassiz (*Proceed. Americ. Acad. of Arts and Sci.* xvii. p. 289, 1882) that the ova of several species of *Cottus* float. In his recent beautiful memoir along with Whitman (*Mem. Mus. Comp. Zool.* xiv. part i. 1885), he again returns to the subject—giving figures and descriptions of the ova of the so-called *Cottus grœnlandicus*, Cuv. and Val., which he found in a pelagic condition abundantly during the summer months, especially in July. The authors, indeed, appear to have met with the ova only on the surface of the sea, and do not seem to have identified them with those in the ovary of the species indicated, which in our country is supposed to be only a variety of *Cottus scorpius*, L. Unless, therefore, the *Cottus grœnlandicus*, C. and V., of Prof. Agassiz, is a form very different, there is room for doubt in regard to this interpretation of its oviposition.

The spawning of the *Cotti* in this country wholly diverges. Instead of the issue of the eggs in detachments, as in most fishes with pelagic eggs, the ovaries of the *Cotti* become distended at the breeding-season with ripe eggs of a uniform size, which are generally deposited in a mass at once—along with a transparent mucous secretion. When ejected into the water the eggs adhere together, but at first they can hardly be lifted on account of the soft and yielding nature of the connecting medium, though they do not readily separate. In a few hours the hardening of the connecting medium and the egg-capsules stiffen the outer layers of eggs, but the central region is still soft. The process of hardening is thus somewhat slow, and apparently depends on free contact with sea-water. These eggs are comparatively large and thick-walled, as well as slow in development, the embryo being ushered into the world in a much more highly organised condition than in the embryos from pelagic eggs. There is, indeed, little resemblance between Agassiz's form and the young *Cottus*, which is considerably larger, is variegated with much pigment, has rudimentary lamellæ (papillæ) on the branchial arches, complex circulatory organs, and a small yolk-sac possessing a single large oil-globule; and it shoots upward into the surrounding water like the young *Liparis* and *Cyclopterus*.

While the newly-hatched *Cottus* therefore greatly surpasses Agassiz's type in complexity, there are certain marine forms, *e.g.* *Anarrhichas*, which as greatly surpass *Cottus*. This will be evident when it is mentioned that the strongest embryos of the wolf-fish are much more highly developed on their escape from the egg than the salmon is for a week or two subsequently. Artificial stocking of the sea with the valuable food-fishes, such as the cod and haddock, would have been comparatively easy if their ova and embryos had been as readily handled and reared. However, since a noteworthy increase in tenacity has been observed in certain forms as soon as the yolk-sac has been absorbed, there is room in this respect for further investigation.

THE HONG KONG METEOROLOGICAL OBSERVATORY[1]

THIS first-class meteorological observatory was erected in 1883, and the regular work of observing began on January 1, 1884. Weather Reports appear monthly, and we have now before us the observations and work of Mr. Doberck and his staff for the first two years. For the first two months the work was restricted to eye-observations, but meanwhile no time was lost in erecting the barograph, thermograph, anemograph, pluviograph, and sunshine recorder, which are similar to those in use at Kew; and from April 1, 1884, the Monthly

[1] "Observations and Researches made at the Hong Kong Observatory in the Years 1884 and 1885." By W. Doberck, Government Astronomer.

Reports include a continuous hourly record of the more important elements of the climate of Hong Kong. The buildings are erected on the peninsula of Kaulung, facing the harbour, on the top of Mount Elgin, a small eminence rising from the plain to a height of about 110 feet above mean sea-level. It may also be noted that the ground has been carefully turfed where the instruments are placed. In addition to the usual tabulations and their averages, the Monthly Report gives a carefully observed log of non-instrumental phenomena, such as dew, fog, unusual visibility, halos, and thunderstorms.

The results show that the amplitude of the daily range of the barometer is greatest from November to February, when the rainfall is least and the air driest, the mean difference during these four months between the morning maximum and afternoon minimum amounting to 0·102 inch. On the other hand, the mean of the four months from June to September, when the monthly rainfall nearly equals 12 inches, only amounts to 0·069 inch. The diurnal range of temperature is small, being for the year only 5°·5, the maximum, 7°·2, occurring in December, and the minimum, 4°·0, in February. The daily minimum occurs at all seasons shortly before sunrise, and the maximum from 1 to 2 p.m. during the dry season, but an hour later during the wet season. The hourly means for the tension of the aqueous vapour are very interesting, as showing very clearly for those months when the sunshine is daily practically constant and the air relatively dry a minimum period during the hottest hours of the day; whereas when the sunshine is much interrupted, the rainfall frequent, and the air moist, the daily maximum tension occurs at these hours.

For the twelve months beginning March 1884, the greatest amount of sunshine was from noon to 2 p.m., and the least from 4 to 5 p.m., the former being per hour nearly double the latter. During the 22 months the greatest monthly number of hours of sunshine for any hour of the day was 26·3 hours from 9 to 10 a.m. of October 1884 out of a possible 31 hours. From midnight to noon the mean monthly rainfall has been 4·98 inches, but from noon to midnight the amount has only been 2·73 inches. The four consecutive hours of largest rainfall are from 5 to 9 a.m., amounting to 1·91 inch, and the four consecutive hours of least rainfall from 8 p.m. to midnight amounting only to 0·76 inch, or considerably less than half the former time of the day. The diurnal period of the rainfall of Hong Kong is remarkable as showing the maximum fall during the period of rising temperature, and the minimum when temperature is rapidly falling, the amounts for the six hours ending noon being 2·66 inches, and for the six hours ending midnight 1·24 inch. Future observations will doubtless modify in some degree the curve of daily rainfall, but from the general accordance of the fall of the individual months with what is indicated above, it is not likely that the change of the curve will be very material.

The daily curves for the winds, both as regards velocity and direction, are very decided. The daily curve for wind velocity has, for Hong Kong, owing to its peculiar position with reference to the island and the continent, peculiar features of its own. Thus for the year the maximum velocity extends from 10 a.m. to 2 p.m., the means for these four hours being the same, while the minimum velocity extends from 6 to 10 p.m., the hour of least movement being from 7 to 8 p.m. From midnight the wind rises to the daily maximum at 10 a.m. The month of greatest force of wind is March, and of least August, the air-movement in the former month being nearly double the latter. As regards direction the wind is about E.N.E. in the winter and E.S.E. in the summer season. For the whole year, the mean direction is E. 3° S., and the diurnal variation from E. 5° N. at midnight to E. 15° S. at noon, the mean variation being thus through 20°. During 1884 the total distance travelled by the wind was 103,237 miles, and of these 63,349 miles, or more than half the whole, was east wind. The least frequent wind is N.W., which showed only 2053 miles.

At a distance of about two miles from the Observatory an important station has been established on Victoria Peak, at which observations are made at 10 a.m. and at 4 and 10 p.m., and the results are published *in extenso* in the Monthly Report. The height of this station is 1823 feet above sea-level. These two almost contiguous stations, the higher being on a peak and the lower also on an eminence sloping directly down to the sea, form an admirable pair of stations for furnishing, in the best procurable form, the observational data necessary for some of the more important physical inquiries of meteorology. So far as we are aware, no pair of stations can be placed side by side with Hong Kong Observatory and Victoria Peak as affording the data for the physical inquiries referred to, except Ben Nevis Observatory and the station at Fort William.

Of these inquiries the important practical question of the rate of decrease of temperature with height may be cited as an example. The remarkable suitability of these two groups of stations for advancing this inquiry lies in the circumstance that in each case the upper station is situated on a true peak, thus reducing to a minimum the influence of the land in changing the temperature of the winds before arriving at the Observatory; and that the lower station is on a rising ground near the sea and sloping down to it, thus minimising the disturbing effects of radiation. At Hong Kong the rate of decrease of temperature with height is 1° for 261 feet in winter; 347 feet in spring; 262 feet in summer; 254 feet in autumn; and 281 feet for the year. At Ben Nevis the rates are for the seasons 279, 251, 268, and 290 feet, and for the year 270 feet—the results being thus closely accordant. On the other hand, such a pair of stations as Obirgipfel in Austria, on a peak 6706 feet high, and the neighbouring station at Klagenfurt, 1437 feet high, cannot furnish the data necessary to this inquiry owing to the circumstance that the lower station is situated in a deep valley. The result is that in January the difference of the mean temperatures of the two stations is less than 1°, although the one is 5269 feet higher than the other; whereas in May the difference of their mean temperatures is 22°·0.

It is earnestly hoped that the publication *in extenso* of the hourly observations at Hong Kong will not be limited to ten years, as seems to be hinted at in the Report, but that the meteorological observations and their publication will be made a permanent part of the work of the Observatory. The unique position of Hong Kong with respect to the great continent of Asia and its meteorology will no doubt secure this object.

CHOLERA IN ITS RELATION TO WATER-SUPPLY

THE epidemic of Asiatic cholera, which has been raging in Spain during the last two years, and which appears even yet to be lurking in some portions of that peninsula, has furnished some interesting data as regards its connection with water-supply, to which it would be wise in us to direct our attention, not only from the interesting nature of the facts as such, but also because it is not improbable that ere the disease quits Europe it may visit our own shores.

Broadly speaking, it would appear that in Spain this formidable disease never became truly epidemic or dangerous in any city in which there was a pure and good supply of water, and proper means were taken to guard against the sources being polluted by any of the specific choleraic poison.

In support of this idea I would desire to call attention to the cities of Toledo, Seville, Malaga, and Madrid, in contradistinction to such places as Aranjuez, Saragossa, Granada, and Valencia. I will commence with Madrid.

This city, whose population at the last census was 397,816, suffered very severely indeed under the last epidemic of 1865, when during several days immediately following a very severe thunderstorm the number of cases varied from 800 to 1200 per day. The first invasion of last year took place in Madrid on May 20, and the disease ran its course during the whole of the summer, gradually disappearing towards the end of the month of September. The total number of cases during the whole of the period was 2207, and the deaths 1366. The total number of cases, therefore, during the five months that the disease never abandoned the city was barely more than what occurred during two days only of the epidemic of 1865, being little more than ½ per cent. of the population. I think, therefore, we may safely say that the disease never assumed a truly epidemic form. The greatest number of cases, as was to be expected, took place during the months of July and August; the first notable increase took place on July 25, and the first notable decrease on August 13.

In connection with this it is interesting to note that Madrid was subject to severe thunderstorms during the latter end of July, and that 119 millimetres of rain fell during the month. These storms began on the 13th, and were especially severe on the 23rd, 24th, 26th, 27th, and 31st, the first notable rise in the cases of cholera occurring between the 25th and 28th. As a general rule, no rain falls in Madrid in July, and the occurrence of these severe thunderstorms and heavy falls of rain was quite phenomenal.

The new water-supply from the Guadarama Mountains was completed shortly before 1865, and the greater part of the drainage was also finished; but at that time the new water supply had scarcely come into use, the large majority of the houses being supplied from the old fountains which existed in various parts of the city. During the last twenty years the use of the Lozoya water has become very general, and an ample supply has been provided for washing the streets and flushing the sewers.

Madrid is now well drained; the sewers are built upon the Paris model, and are not what an English engineer would consider as a good type for self-cleansing purposes, but the fall is, in almost every case, very great, and it is not probable that there can be any collection of fœcal matter at any point. The connection of the street gulleys with the main sewers is made without any trap, and good ventilation is thus provided. As regards the outfall of these sewers, nothing satisfactory can be said. The mouths of the main sewers, which are seven in number, all discharge on the southern side, between the station of the Saragossa Railway and that of the Northern.

The question of the proper disposal of the sewage in Madrid, as in London, has never been decided, and pending this decision the sewers were completed only as far as the outlying houses of the city, and the sewage was then allowed to find its way down to the Manzanares, in the best way it could. During the time the question has been awaiting a solution the town has extended, and houses have been built along the course of these open sewers. As might have been expected, the first serious outbreak of cholera occurred about these spots, the original germ of the disease having been imported from the neighbourhood of Valencia, where the cholera was then raging.

The existence of the disease having been established beyond doubt, one of the first acts of the Municipality was to attend to the water-supply. There existed 12 ancient sources, which supplied 85 taps or fountains, 22 of which were public ones, at which water-carriers were allowed to fill their barrels, and the remaining 63 belonged to groups of houses. In spite of the excellent supply brought in from the Lozoya, these old sources were still a good deal used by the inhabitants—many, from old habits, preferring to use the same water which their fathers had used, many not being willing to incur the expense of laying on the new supply. In view of the impossibility of effectually guarding against the possible contamination of so many sources of supply, the Municipality, by decree on June 18, closed all the old ones with the exception of that of La Fuente de la Reina, which supplied five public fountains and four private ones. The Central Government undertook the custody of the Lozoya aqueduct, the Municipality took charge of the Fuente de la Reina. The Lozoya water is drawn from the sources of the River Lozoya in the Guadarama Mountains, some 50 miles to the north of Madrid.

The river takes its rise in the granite formation; the water is excellent, and from the uninhabited condition of the country through which the river flows before the intake, it is not exposed to direct contamination from any specific poison. From the intake to Madrid the water is conducted by a series of magnificent works, partly covered, partly uncovered, to Madrid, where it is received in covered reservoirs before being distributed in the city; the service is continuous, no cisterns being used. During the whole time of the existence of cholera in the city the uncovered portion of the aqueduct was patrolled by armed guards, no one being permitted to approach without a special order.

Accompanying the extensive Report of the Mayor of Madrid, Don Alberto Bosch, amongst other plates is an excellent map of the city, showing, by a red dot, the situation of every case of cholera that occurred; they are seen pretty thickly scattered about the uncovered exits of the sewers, and on both sides of the River Manzanares—which is, in fact, in summer an open sewer—and in the lower portion of the city overlooking the river, and there is scarcely any part of the town where a dot is not to be found; but, with the exception of the points mentioned, the cases occurring in the remainder of the town seem to be all isolated ones; in extremely few cases do two dots occur together, showing that the disease was more of a sporadic than of an epidemic character.

Now let us take the case of Toledo. This ancient capital of Spain is certainly not a city that could be taken as a model of sanitary arrangements; on the contrary, it seems to be admirably adapted to form a good nest for any wandering epidemic, and yet, although the cholera entered it in the summer of 1884, and did not finally leave it till the autumn of 1885, the total number of cases, according to official returns, did not exceed 200, of which about one-half were fatal. The population of Toledo is over 20,000, so that the percentage of choleraic disease was only about 1 per cent. of the population for the two seasons.

Toledo was supplied with water from the River Tagus, which flows round the city, the water being lifted by pumps. Above Toledo, on the same river, is situated Aranjuez, and above Aranjuez again, on the Manzanares, which is a feeder of the Tagus, is situated Madrid, in both of which towns the cholera existed in 1885, being unusually severe in Aranjuez. The Governor of the province, recognising the suspicious character of the water, stopped the pumps, and obliged the inhabitants to send for their drinking-water to a distant spring; he even forbade any one to bathe or wash clothes in the river. The measure was a strong one, but it saved the city.

Let us next take Seville. Seville is an important city, the third in rank in Spain; it contains, according to the census of 1877, 134,318 inhabitants; it has, strictly speaking, no drainage; a few ancient sewers exist for carrying off the rain-water from the lower portion of the city, but sewerage for houses does not exist. The sewage goes into cesspools, which are, in most cases, situated just outside the house, and under the street; the inhabitants are extremely cleanly in their habits, and the outsides of their dwellings are constantly whitewashed, but it is not a healthy city—typhoid fever is endemic, and the death-rate rises in some parishes to 35 per mil.

Seville is situated on the River Guadalquiver, of which the Rivers Darro and Genil, that flow through Granada, are feeders; as regards its water-supply, one suburb of the city, called Triana, containing about 30,000 inhabitants, is situated on the western side of the river. This portion is almost entirely inhabited by the poorer class, and they drink generally the water of the river.

The rest of the town is supplied from an ancient Roman or Moorish aqueduct, the water being brought from an underground spring near the town of Alcalà, about nine miles to the east of Seville; this water is carried by a tunnel about two miles in length under the town of Alcalà; it is then carried in a covered conduit to within a short distance of Seville, and from thence by an aqueduct made by the old Moors. The water is excellent.

An English Company has quite lately erected engines at Alcalà, by means of which they pump up to a covered reservoir above the town the water from two other springs, situated also at Alcalà, but on the opposite side of the river Guadaira, which flows past the town. This water is carried from the reservoir into the town by iron pipes, and distributed under considerable pressure; in character it is pure and excellent; the springs rise from the base of the sandstone at a short distance from the engine-house, and are carried across the river by an iron pipe. The cholera broke out in Granada on July 14, 1885, but already on June 14 of the same year the authorities of Seville, by way of prevision, had prohibited the use of any water from the river, either for dietetic or other purposes; had authorised the English Company to lay a temporary pipe across the bridge which connected the city with the Triana suburb, and had opened a number of free taps from which the inhabitants of this suburb could draw the new water.

The old Moorish supply was scarcely susceptible of contamination, as the conduit was covered for the greater part of the way, and where it ran over the aqueduct no one but the Municipal guards had ever been allowed to pass; guards, however, were stationed day and night on the springs from which the English Company derived their water, and no one was allowed to approach them without permission.

The cholera raged fearfully in Granada during the months of July, August, and September; it descended the River Genil, which runs through Granada, and attacked the towns of Herera, Ecija, and others in the province of Seville. It broke out also at Cordova and other towns on the Guadalquivir, of which the Genil is an affluent, and it broke out in Palma, Utrera, Puerto Real, Puerto Santa Maria, and Cadiz, forming a circle round Seville, but the city itself escaped almost completely. Towards the end of September nine cases occurred in one quarter of the city, of which seven were fatal, but the disease did not spread; none of the five houses in which these cases occurred were connected on to the water-supply, and it is possible they may have used well or river water, although this is not known. Jerez, which lies about halfway between Seville and Cadiz, and close to the town of Puerto Santa Maria, which was attacked by cholera, escaped also from the disease. This town possesses a very excellent water-supply, brought down some few years ago from a spring in the mountains by a native Company, at a cost of 300,000*l*.

Malaga has a population of 115,882. This city is in even a worse sanitary condition than Seville as regards its drainage, and a great deal worse as regards its cleanliness. In the old portion of the town the streets are narrow, unventilated, and intolerably filthy; the climate in summer is almost tropical.

It is difficult to obtain reliable data as to the cases of cholera in Malaga, as attempts were made to prove that no real cholera existed in Malaga; but there can be no doubt that from June to September the cholera did exist, and it is probable that during the whole of the summer there occurred some 200 or 300 real cases of Asiatic cholera. But the disease never became epidemic, although to all appearances the city offered a most excellent medium for the propagation of the disease, and on all former visitations had suffered very severely. But Malaga during the last few years has been provided with an excellent water-supply drawn from some springs situated at Torremolinos, on the coast to the westward of the city, and piped from thence into the city; and although the precautions adopted were not so complete as those at Seville, yet a more or less successful attempt was made to prevent the use of any other water than that brought from Torremolinos.

We have now examined the case of the few towns in Spain that possess a pure supply of water drawn from springs not liable to any specific contamination, and we have seen that, in all cases where such a supply existed, the cholera, although present in all of them, never made any headway or became truly epidemic, although in every case, except that of Madrid, there was no proper drainage, and the sanitary conditions were in many cases as bad as they could be.

Let us now look on the other side of the picture. We will commence with Granada—population 76,005. As regards its sanitary arrangements this city is on a par with Malaga; about one-tenth of the town is drained, but the sewers are of a very inferior class The city is supplied with water by canals derived from the Genil and Darro, the two rivers which serve to irrigate the magnificent plain which spreads round it. A small portion is supplied from a spring called La Fuente Grande de Alfacar. The canals are uncovered, and are exposed to all kinds of contamination.

Through the streets the water is conducted in earthenware pipes, after the style of the Moors; many of the pipes are the original ones put down by these people before the conquest of the city by Ferdinand and Isabella. The cholera broke out about the middle of July. It is supposed to have first been brought in by some labourers who had arrived from Murcia, where the cholera was raging. It spread with frightful rapidity, and by the middle of August the official number of cases reported was over 450 per day. It died out, or rather wore itself out, about the middle of September. The total official returns give a total of 6471 cases and 5093 deaths, but in the city itself these returns are said to be much under-estimated; some, indeed, say the numbers should be doubled.

No attempt was made, as was done at Toledo with such excellent results, to suppress the old water-supply, and the epidemic took in a short time such alarming proportions that the local authorities were completely paralysed. It was difficult to carry on the interment of the bodies, and at one time from 400 to 500 corpses were lying piled up in the cemetery, awaiting interment.

The course of the cholera may be followed down the Rivers Darro and Genil, the infected waters carrying death wherever they were used for drinking-purposes.

Murcia—population 91,805—from which the cholera was imported into Granada, suffered heavily also. It was carried into the plains of Murcia by the waters of the River Segura from the baths of Archena, and it was imported into Archena by some invalid soldiers who were sent to the baths from the infected district round Valencia. The plain of Murcia is irrigated by the waters of the Segura, and the disease commenced in this district with the death of a labourer who had drunk the water of one of the irrigation channels. The inhabitants of Murcia and of the plain use principally water from the irrigation canals or from the river; this water is usually stored in large jars similar to those which held Ali Baba and his forty thieves, and amongst well-to-do people it is customary to keep a year's supply in hand; that is to say, the water is allowed to repose for one year before use in a reservoir or "algibe," constructed on purpose, or in some of these large jars sunk up to their necks in the ground; by this means it becomes perfectly clear, cool, and palatable. The poorer classes are, as a matter of course, not able to take these precautions, and have to drink the water from the canals, or after a few days' repose only.

The epidemic raged principally amongst the little cottages scattered thickly over the plain or garden, as it is called, but the disease never developed itself in Murcia as it did in Granada, and the city itself escaped better than might have been expected. May this not be attributed to the fact that the greater part of the people in the city were drinking water collected in the foregoing year, before the cholera had appeared on the sources of their water-supply? And if this be so, may we not anticipate a fresh outbreak this year, if the choleraic poison or germs are capable of outliving a year's repose and darkness?

In reference to water-supply and cholera, no case is so instructive as that of Valencia. This city is fairly well drained, as drainage goes in Spain, and as regards cleanliness is certainly in a better situation than Malaga or Granada. The water-supply is derived from the River Turia; it is taken from the river near the town of Manises, about three miles and a half above Valencia; it is passed through sand filters situated between Manises and Mislata, and is stored in a covered reservoir, from whence it is conducted by iron pipes, a distance of about one mile and a half into the city.

In one of the interesting letters written by the special correspondent of the *Times* during his tour of inspection of the cholera districts, a very clear description is given of the track taken by the cholera from its starting-point in Alicante, where it had broken out at the latter end of 1884, to Valencia in 1885. During the course of the year 1884 the disease had crossed the frontier of the provinces of Alicante and Valencia, and established itself at Jativa, a somewhat important town, situated on one of the affluents of the Jucar—this and the Turia being the two rivers whose waters are used for the irrigation of the wonderful "Huerta," or Garden of Valencia. During the winter the disease lay dormant, but it broke out in the spring of 1885, and travelled rapidly down the river to Alcira, attacking the various towns situated on the river itself, or on the canals derived from it.

The epidemic was severe at Alcira, but, as the *Times* correspondent suggestively remarked, it ceased so soon as the inhabitants gave up drinking the river-water, and took their supply from a spring situated at a considerable distance from the town. From Alcira it travelled across the network of canals till it reached the river Turia. The *Times* correspondent says:—"It came very near Valencia, and yet never touched the capital till it had worked right round."

At last, in the middle of May, having crossed the water-supply of the city and thoroughly infected the river, it attacked the city right royally, and by the end of June the number of cases had risen to 700 daily, out of a population of 143,861. The disease died out in September, having, according to the official accounts, attacked during the four months 4234 people.

We will now turn to Saragossa. Saragossa, the capital of the ancient kingdom of Aragon, is situated on the right bank of the River Ebro; it contains 84,575 inhabitants, and is an important city. Like most Spanish towns and cities it has no sewers: fœcal matter is collected, as in Seville, in cesspools, which are periodically emptied.

Its principal water-supply is derived from the Canal de Aragon, which in its turn draws its supply from the Ebro, near Tudela. This canal was intended principally for navigation, and is now used for this purpose, and also for irrigation. It passes at a short distance above Saragossa, and the town supply, after being drawn from the canal, is stored in reservoirs, and, after depositing its mud, is then passed through charcoal filters. Some of the inhabitants of the city drank the water from an irrigation canal taken from the River Jalon; some used the waters of the Ebro, which flows close past the old walls of the city.

The disease broke out in Saragossa shortly after the middle of July, and the number of cases during the time the epidemic raged was close upon 10,000. The proportion of deaths was small, thanks to the heroic and energetic conduct of the authorities and the people. Some time before the commencement of the disease in the city a number of small towns on the banks of the Ebro and the Jalon had been attacked by the cholera; there was therefore ample opportunity for the infection of the water-supply. Against such contamination the only protective measure as regards the general supply was the filtration through charcoal; as regards the Jalon water, there was no protection. This source of supply was, however, ultimately stopped by the authorities, who prevented the water reaching the city, with a notable result as regarded the decrease of the epidemic in the quarter served by them.

It would be interesting to follow out still further the line of inquiry I have adopted, but the examination would be too prolix for the present purpose. The cases I have presented are typical ones; they might be increased *ad libitum*, but I think they are sufficient for my purpose. From an examination of them it would appear as though, in the case of cholera, drainage and sewerage is a secondary subject, the primary one being the water-supply. We have seen that the cities of Toledo, Seville, and Malaga, although in bad conditions as regards their sewerage and general sanitary arrangements, yet escaped from any serious attack of cholera, whilst Murcia, Valencia, and Saragossa suffered most severely, although in their case the sanitary arrangements were certainly not worse, but if anything better, than the three former cities. But, in the case of the three first-named cities, each one enjoyed a supply of water drawn from springs situated at a distance from the city, and carefully watched and guarded to prevent any contamination, and the exclusive use of this water was rendered imperative by the authorities.

In the case of Valencia, Saragossa, and Murcia we have a supply drawn from rivers subject to contamination from various sources, against which the only protection was that furnished by the doubtful process of filtration.

There can be no doubt that the cholera attacks in preference those who live under unsanitary conditions, and whose habit of body is by this means prepared to receive the germs of any disease that may be prevalent.

There is no doubt that the virus can be conveyed about from one place to another, like small-pox, typhus, and various other diseases, either by clothes or in the human body, and where it finds a proper medium it will develop itself and extend; but, like these other diseases, it can in these conditions be isolated, fought, and conquered, but without doubt the medium *par excellence* for the spread of cholera-poison is water, and more particularly so when water so infected is used for dietetic purposes.

When it gets possession of the water-supply of a city, no bounds can restrain it; there is but one resource, and that is the cutting off of the water.

We do not yet know in what the choleraic poison consists; it is in all probability a micro-organism of some sort which is capable of very rapid development in water, but it cannot be yet said what is the particular micro-organism which produces cholera. The "comma Bacillus" of Koch has not been accepted by the scientific authorities; on the contrary, very high ones deny altogether its identity with cholera, and assert that it is to be found in the mouth of every healthy person. Whatever the specific germ may be, it is at least doubtful whether any filtration will intercept it; from the experience obtained at Valencia and Saragossa it appears evident that neither sand nor charcoal will do so.

In a paper read recently at the Institute of Civil Engineers, Dr. Percy Frankland asserts that the London Water Companies do, at the present moment, eliminate 96 per cent. of all the micro-organisms in the Thames water by simple filtration through 3 feet of fine sand. This may be so, but it is equally certain that filtration through sand, even at a very slow speed indeed, will not eliminate the minute particles suspended in waters of a deltaic character, and which gives such waters their peculiar colour. If sand is incapable of intercepting these particles, it may also be incapable of intercepting the specific germs or poison that produce cholera in the human body.

Filtration is, at the best, but a doubtful proceeding for the purification of water. It is impossible to control effectually the speed of the filters; they vary at every moment, and although a mean term may be arrived at by taking the area of the filter-beds and the volume of water filtered in the twenty-four hours, yet this really affords no reliable guide as to the actual speed at which the water has passed the filters. It is probable—nay, almost certain—that, out of a given quantity of water, no two gallons have passed at the same speed, and it is possible and probable that one-half of the total volume may have passed the filter at double or treble the speed of the rest.

To insure immunity from contamination, the only real and practical method appears to be that of capturing the water at a pure source and conducting and delivering it in such a way as to render it impossible that any specific germ or poison should have obtained access to it. In the matter of cholera, for instance, with the experience of Valencia and Saragossa before us, one cannot feel any confidence in water which is taken from a river liable to so many sources of contamination as is the Thames, and it is at least doubtful whether any system of filtration would be capable of eliminating cholera-poison from such waters. It is extremely probable that simple filtration through sand will not do it.

The very interesting series of letters published by the *Times* on the subject of cholera in Spain afford much valuable data as to the causes of the disease, or rather as to its mode of propagation. It is unfortunate that the writer seems to have gone out with a preconceived idea that the cause of the propagation of cholera was defective drainage, and consequently to have devoted the greater part of his time to the examination of the sewerage of the various towns he visited, and of their general sanitary arrangements, the water-supply being as a rule relegated to the second place. He appears to be a strong advocate for traps, and not to be aware that the best sanitary authorities of the present day are beginning to doubt very strongly the utility of traps, and to rest their practice rather on the thorough ventilation of sewers, the rapid discharge of their contents, and a complete disconnection between the house drainage and the main sewers.

It is not too late for some scientific investigator to go over the track of the cholera invasion in Spain, to trace the progress of the disease in the towns it visited, and ascertain all the facts connected with their drainage and water-supply, and also, what is not less important, examine the conditions of those towns which so far have enjoyed a practical immunity from the epidemic. As much is to be learned from this negative evidence as from the other.

Pending the discovery by scientific men as to the particular germ or poison that creates cholera, such a practical examination as I suggest would be of immense value to us, by teaching how the propagation of the disease is principally brought about, and what are the best means of preventing it.

GEORGE HIGGIN

NOTES

THE Royal Society *conversazione*, on June 9, was in all respects satisfactory. We can only afford to refer briefly to a few of the exhibits which attracted the interest of the numerous visitors, who were received by Professor and Mrs. Stokes. A room was devoted to telephones connected with the Savoy Theatre, and the company were delighted to hear the Mikado under such novel conditions. The models of the Romano-British village near Rushmore, on the borders of Dorset and Wilts, between Salisbury and Blandford, exhibited by Lieut.-Gen. A. Pitt-Rivers, F.R.S., attracted much attention. The rare earths from samarskite, gadolinite, &c., with illustrations of their phosphorescent spectra, exhibited by Mr. W. Crookes, F.R.S., were magnificent. The pumice, volcanic ash, drawings, diagrams, &c., illustrative of the effects produced by the great eruption of the island of Krakatão, Java, in August 1883, exhibited by the Krakatão Committee of the Royal Society, proved very attractive, as did the fine collection of astronomical photographs exhibited by Mr. Common, Dr. Gill, the Solar Physics Committee, and others. At 9.30 and 10.30 the stellar and solar photographs were demonstrated, and at 10 Mr. Common demonstrated the photographs of nebulæ and comets. The first series included the stellar photographs recently taken by the Brothers Henry at the Paris Observatory. The remaining photographs had reference to solar phenomena, and consisted of two series, one from Meudon, the other from Kensington; the former, contributed by Dr. Janssen, had reference to the minute portion of the solar surface; the latter, to some recent attempts to photograph the spectra of sunspots and prominences. The photographs of planets, comets, and nebulæ, exhibited by Mr. A. A. Common, F.R.S., consisted of (1) series of photographs of Saturn; (2) series of photographs of Jupiter; (3) photograph of Mars; (4) nucleus of the great comet 1882; (5) the Dumb-bell Nebula; (6) the Crab Nebula; (7) the Spiral Nebula; (8) the Great Nebula in Andromeda; (9) series of photographs of the Great Nebula in Orion, with exposures of 1 min. to 80 min. (the above were all taken with the 3-foot reflector at Ealing); (10) recent photographs of Saturn, Jupiter, and the nebulæ in the Pleiades, by the Brothers Henry.

AT the annual meeting of the American Academy on May 25, it was voted to present the Rumford gold and silver medal to Prof. Langley, of the Alleghany Observatory, for his researches on radiant energy.

THE thirteenth annual meeting of Scandinavian naturalists will take place in Christiania between July 7 and 12.

WHILE Mount Etna has again quieted down during the past week, volcanic energy has manifested itself at the Antipodes in an unexpected quarter. Though the North Island of New Zealand is known to be greatly volcanic, and has in Tongariro an active volcano, there has been no destructive eruption within the memory of man. The eruption therefore telegraphed on June 10 was quite unexpected. It occurred in the Tarawera district, on the east side of the Tarawera Lake, lying in a line between the Bay of Plenty and the mouth of the Wanganui River. It is a long way north from Tongariro, and in the midst of the wonderland of Rotomahana's hot springs and many-coloured terraces. The country is stated to be in a disturbed state for many miles around, and it is estimated that a hundred natives and ten Europeans have perished.

A SHOCK of earthquake was felt on Friday night at Sandy Hook and Coney Island, New York, U.S.

An earthquake was felt at Bougie, Algeria, on June 10; no accidents are recorded. On the same day a heavy thunderstorm raged in the vicinity of Versailles. The lightning struck a tent at Sautenay camp; sixty soldiers were lying under it; many were hurt, but none killed.

Arrangements are in progress for the establishment of an aquarium and winter garden in Stockholm.

During the present summer a university will be opened at Tomsk, in Siberia, the first of its kind in this part of the Russian Empire. At first it will consist of two faculties—a historical-philological one and a physical-mathematic. It already possesses a library with 50,000 books, a very valuable palæontological collection, presented by Duke Nicolaus of Leuchtenberg.

Early last year the East Indian section of the Dutch Royal Institution of Engineers published some prize questions for essays. One of these subjects was the theoretical methods and calculations used when making deductions from observations on earthquakes, together with positive data as to the situation of the point of egress of a given shock. The first prize of 150 guilders and a diploma was awarded to Prof. Milne of Japan. He also received honourable mention for an essay on another question respecting the application of the theoretical principles of seismological science to the art of house-building, especially in the Netherlands Indies, the prize committee at the same time asking for permission to use his observations and suggestions in a work under preparation by one of the members of the committee, who has studied Javanese seismological phenomena and Javanese methods of architecture.

In a paper in the last number of the *Journal* of the American Oriental Society Dr. Martin, the head of the Foreign College at Pekin, writes on the "Northern Barbarians" of Ancient China, or the tribes which harassed the northern frontier. The ethnology of these and other tribes inhabiting China and the adjacent regions is at present engaging much attention from Oriental scholars, and especially in England that of Prof. de Lacouperie. Dr. Martin confesses that we are still in darkness respecting the ethnology of these northern tribes. Even in regard to the great tribe of Hiongnu, which is conspicuous in history for many centuries about the commencement of the Christian era, it has been much disputed whether they were Turks, Huns, or Mongols. Dr. Martin thinks that these tribes of prehistoric times were probably not inferior to the Chinese in form, feature, or natural intelligence, as their descendants, the Manchus and Mongols, are not inferior in any of these respects. In reply to the question were they originally of one mould, or have the lines of distinction become gradually effaced by the intercourse of ages, he thinks the latter the correct hypothesis. He believes that the primitive Chinese type, that imported by the immigrants who founded the civilisation of China, is no longer to be discerned. In the southern and central regions it has everywhere been modified by combination with the aboriginal inhabitants, leading to provincial characteristics, which the practised eye can easily recognise. It has probably undergone a similar modification in the northern belt, where it met with tribes akin to those of Mongolia, and gradually absorbed them. This process was going on in prehistoric times; history at its earliest dawn shows us the unassimilated fragments of these tribes, and at the same time discloses a vast movement southward all along the line. In the historic period these tribes, organised into great states, established in China a dominion enduring for centuries. They have, Dr. Martin thinks, stamped their impress on the people of this region as thoroughly as the Saxons have theirs on the people of England, or the Vandals theirs in that part of Spain which still bears their name in the form of Andalusia. In their turn the invaders have been subjected, in all ages, to influences under which they exchanged barbarism for such civilisation as they found among the more cultivated race.

The assertion that from the top of the Eichel tower communication could be established with Dijon, a place situated 304 kilometres from Paris, is not quite correct. The altitude of this proposed monument being only 300 metres, the radius of the horizon could not exceed 80 kilometres, if we disregard the inequalities of the surface. But the mountains which separate the basin of the Seine and that of the Rhone, which are in Côte d'Or, although not very lofty, may possibly be perceived from an elevation of 300 metres at Paris, under the most favourable circumstances, and they are not very far from Dijon. Practically such a tower could be used for placing Paris in communication with any army occupying these mountains. These facts are sufficiently proved by the success of the great triangulation executed by Col. Perrier between the province of Oran and the Sierra Nevada at a distance of over 200 kilometres. The question is, if it is possible to erect this structure, whether it is worth the money required to build it, and whether the effect will not be to destroy all harmony in the great Exhibition. This question is not settled yet.

With reference to Mr. Caldwell's observations in which he found that Monotremes are oviparous with mesoblastic ovum, a correspondent sends us the following quotation from a work by Robert and Thomas Swinburn Carr, entitled "The Literary Pancratium," foot-note on p. 8 (London, 1832):—"But this is New Holland, where it is summer with us when it is winter in Europe, and *vice versâ*; where the barometer rises before bad weather, and falls before good; where the north is the hot wind, and the south the cold; where the humblest house is fitted up with cedar; where the fields are fenced with mahogany, and myrtle-trees are burnt for fire-wood; where the *swans are black* and the eagles white; where the kangaroo, an animal between the squirrel and the deer, has five claws on its fore-paws, and three talons on its hind-legs, like a bird, and yet hops on its tail; where the mole lays eggs, and has a duck's bill; where there is a bird with a broom in its mouth instead of a tongue; where there is a fish one half belonging to the genus *Raja* and the other to that of *Squalus*; where the pears are made of wood, with the stalk at the broader end; and where the cherry grows with the stone on the outside.—Field's *New South Wales*, p. 461."

Just as improved machinery, adopted in a locality to which the old trade was a stranger, through not being there hampered with old customs and much invested capital, may bring with it the future trade, so an intelligent and rapidly-progressing nation like Japan, by the free choice of the latest improvements in educational organisation from both Europe and America, may even have something to teach. Hence the United States Bureau of Education has lately published a circular containing a statistical survey of the system now adopted there. There is a Minister of Education over all; candidates for school committees are nominated by each locality—either a large city or a province—into which the country is divided; a selection is made from them by the Governor, and the chosen members are paid. There are schools of general education divided into three grades, to pass through all of which occupies eight years. The study of literature gives the choice of either Japanese or Chinese, the former requiring three years, the latter four. English, or if preferred, French or German, is required to be learnt in all middle-class schools, as well as in the highest. At the one University a course of instruction in the department of science is provided in mathematics, physics, chemistry, biology, astronomy, engineering, geology, mining, and metallurgy. There are astronomical and meteorological observatories, botanical gardens, and museums. Courses are provided in medicine, leading up to a special degree after a course of five years, and in pharmacy after a course of three. Independent of the University are the Military Academy and the Engineering College, the last two out of the six years' course of the latter being spent in practical applications. Technical education is divided into chemical and mechanical. There are higher schools in the country for nearly every special purpose; but with all this carefully-proportioned system the titles and objects of thirty societies show how thoroughly the English system of voluntary association is making its way as a method of supply to educational demand.

ON presenting to the St. Petersburg Academy of Sciences his new researches into the language of his "Codex Comanicus," published by Count Kunn, Prof. Radloff made a few remarks well worthy of attention (*Bulletin*, vol. xxxi. No. 1). After having carefully catalogued all words appearing in the "Codex," Prof. Radloff has collected, under each separate word, the words akin to it in different Turkish dialets, so as to show their kinship at once. It appears that the Comanic dialect belongs to the great group of Turkish dialects which M. Radloff describes as the Kypchak group; the parent language having been spoken from the ninth to the thirteenth centuries by those Tartars who inhabited the Steppes from the Altai Mountains to the Black Sea. They now comprise the Abakan Tartars, the Barabintsys, the Irtysh and Kazan Tartars, and the Kirghizes. The "Codex" thus offers a sample of the oldest language spoken by the Kypchak stem. After having concluded his researches into this dialect, Prof. Radloff will devote his attention to the Uigur languages, for which we have so rich a material; and then he will take up the third group of the Seldjuck languages. Only after such an inquiry, he says, may we hope to attain a thorough knowledge of the whole of the Turkish languages, because all the newer material, and much of the older, belongs to the artificial written languages. The Osman and the Jagatai (or East Turkish) dialects are not representatives of defined groups of dialects, but artificial languages based, the latter on the Uigur language, and the former on the Seljuk, with a mixture of different other dialects. As to the Kazan written language, it is a most varied mixture, in which Osman are mingled with Djagatai forms, while the people are acquainted with neither of them.

WE have received the *Proceedings* of the Windsor and Eton Scientific Society for the past year. It contains reports of a few lectures on general scientific subjects. We do not see any evidence of that local scientific work for which these societies are so remarkable, and which is the most beneficial outcome of their activity. Still, the President, who must be a good judge, in his address for the year states that the Society is steadily but surely making its mark as one of the many aids to intellectual improvement which are offered to the people of Windsor and the neighbourhood by the Albert Institute and the various societies associated with it.

COMMENT was made in this journal on a recent date respecting the enemies of frogs. Mr. W. August Carter, of the Fisheries Section of the Colonial and Indian Exhibition, has made further observations upon the subject, and finds that the tortoise must be added to the list of foes. With a view of substantiating this fact Mr. Carter placed some medium-sized frogs with several tortoises of the same dimensions, when the latter immediately attacked them ferociously, and held them firmly by the legs, notwithstanding their efforts to escape. The tortoises were, however, unable to devour more than a portion of the leg, which they did with much apparent difficulty, the frogs afterwards escaping, but only to be recaptured and similarly treated. Considering the tortoises measured only 1¼ inches in length, they displayed remarkable courage, whilst their agility was certainly greater than that usually displayed by these members of the Chelonian family.

A VERY large specimen of the Ascension turtle died at the Colonial and Indian Aquarium last week. It was the only one of this species on view, and had been the object of considerable notice on account of its colossal proportions. As a further proof of the tenacity of life amongst turtles, it may be remarked that this particular specimen had existed more than two months without food. At its death 100 eggs were found in it, the retention of which doubtless proved fatal to the turtle.

THE additions to the Zoological Society's Gardens during the past week include an Ourang-Outang (*Simia satyrus* ♀) from Borneo, presented by Mr. H. H. Riccard; a White-handed Gibbon (*Hylobates lar*) from the Malay Peninsula, a Binturong (*Arctictis binturong* ♂), a White-whiskered Paradoxure (*Paradoxurus leucomystax*) from Malacca, presented by Mr. Dudley Hervey; a Binturong (*Arctictis binturong*) from Malacca, presented by Capt. Robert Hay; a Common Genet (*Genetta vulgaris*), South European, presented by Mr. J. Church Dixon; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Miss Grace Balfour; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mr. Duncan Armstrong; an Indian Civet (*Viverricula malaccensis* ♂) from India, presented by Capt. Archibald Douglas, R.N.; a Herring Gull (*Larus argentatus*), British, presented by Mr. C. A. Marriott; two Black-billed Tree Ducks (*Dendrocygna arborea*), a Violaceous Night Heron (*Nycticorax violaceus*), a Brazilian Cormorant (*Phalacrocorax brasilianus*), a Fugitive Snake (*Dromicus fugitivus*) from the Bahamas, presented by Mrs. E. Blake; two Mexican Guans (*Penelope purpurascens*) from Mexico, presented by Mr. E. A. Clowes; a Garden's Night Heron (*Nycticorax gardeni*) from St. Kitts, West Indies, presented by Dr. A. Boon, F.R.C.S.; seven Common Vipers (*Vipera berus*), from Hampshire, presented by Mr. Walter Blaker; four Three-toed Sand Skinks (*Seps tridactylus*), South European, presented by Mr. J. C. Warbury; a Puma (*Felis concolor*) from South America, a White-handed Gibbon (*Hylobates lar*) from the Malay Peninsula, ten Adorned Ceratophrys (*Ceratophrys ornata*) from Buenos Ayres, deposited; two Viscachas (*Lagostomus trichodactylus* ♀ ♀), two Crossed Vipers (*Craspedocephalus alternatus*) from Buenos Ayres, a South American Flamingo (*Phœnicopterus ignipalliatus*), a Roseate Spoonbill (*Platalea ajaja*) from South America, a Harnessed Antelope (*Tragelaphus scriptus*), two Balearic Cranes (*Balearica pavonina*) from West Africa, two Lineated Kaleeges (*Euplocamus lineatus* ♂ ♀) from Tenasserim, a Porose Crocodile (*Crocodilus porosus*) from Ceylon, a Bald Ouakari (*Brachyurus calvus* ♂) from Brazil, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE MELBOURNE OBSERVATORY.—We have received Mr. Ellery's Report, dated October 6, 1885, which refers to the year ending the previous June 30. The great reflector, after some slight repairs, readjustments, &c., is stated to be in excellent working order. The work done with this instrument has been chiefly confined to a revision of southern nebulæ, already observed by former observers, preliminary to publication. One hundred and seventy-two nebulæ have been re-observed and re-drawn to compare with the plates to be published. Many of these nebulæ have been observed twice, and some three times, and none were completed until they had been observed on a first-class night. The new transit-circle with object-glass of 8 inches aperture, constructed by Messrs. Troughton and Simms, has been in continuous use for all the meridian work of the Observatory since August 22, 1884, and has proved very satisfactory in every respect. The number of right a cension observations obtained with this instrument since its erection was 2287, and the number of declination observations 983, comprising observations of a list of stars selected by Dr. Auwers for reduction of zone and Transit of Venus observations, stars observed with comets, and stars selected from the Melbourne zones. All the individual observations are completely reduced. The second Melbourne general catalogue, containing the meridian results from 1871 to 1884 inclusive, thus incorporating the whole of the results obtained with the old transit-circle up to the date of its disuse, is in process of formation. An alteration has been made in the photo-heliograph, so as to secure a picture of 8 inches diameter instead of 4 inches, as formerly. There have been several interruptions to the continuity of the sun-photographs during the year, owing to derangement of the instrument and dome, and only 130 pictures were obtained up to June 11, when the instrument was dismantled for repairs. The sixth volume of the results of astronomical observations for the years 1876 to 1880 inclusive, was published in February 1885, and has been distributed. The first part of the observations with the great Melbourne telescope (NATURE, vol. xxxiii. p. 538), from its erection in 1869 to the present date, has also been published during the year to which this Report refers.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *JUNE* 20-26

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

At Greenwich on June 20

Sun rises, 3h. 44m.; souths, 12h. 1m. 14·5s.; sets, 20h. 18m.; decl. on meridian, 23° 27′ N.: Sidereal Time at Sunset, 14h. 14m.

Moon (four days after Full) rises, 22h. 7m.*; souths, 2h. 49m.; sets, 7h. 36m.; decl. on meridian, 15° 34′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 17	12 45	21 13	24 57 N.
Venus	1 50	9 14	16 38	15 14 N.
Mars	11 28	17 45	0 2*	2 41 N.
Jupiter	11 40	17 56	0 12*	2 19 N.
Saturn	4 40	12 50	21 0	22 37 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)

June	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
21	B.A.C. 7487	6½	0 36	1 55	89 258
24	24 Piscium	6½	0 43	1 47	87 241

June
21 ... Sun at greatest declination north; longest day in northern latitudes.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	June 24,	1 14	*m*
R Virginis	12 32·7	7 37 N.	,, 25,		*m*
W Virginis	13 20·2	2 47 S.	,, 26,	2 20	*M*
δ Libræ	14 54·9	8 4 S.	,, 26,	23 32	*m*
U Coronæ	15 13·6	32 4 N.	,, 20,	20 41	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 21,	2 14	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	June 26,	2 0	*M*
U Sagittarii	18 25·2	19 12 S.	,, 22,	3 0	*M*
β Lyræ	18 45·9	33 14 N.	,, 26,	21 30	*M*
η Aquilæ	19 46·7	0 43 N.	,, 23,	22 0	*m*
T Delphini	20 40·1	15 59 N.	,, 23,		*M*
δ Cephei	22 24·9	57 50 N.	,, 22,	2 30	*m*
R Pegasi	23 0·9	9 56 N.	,, 25,		*M*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES

THE paper on the aborigines of Formosa, by Mr. G. Taylor, in the *China Review*, to which we have already adverted, is continued in the last number (vol. xiv. No. 4), and as it progresses it contains more and more information, especially with regard to the number of different tribes and their various customs, which is wholly new, either in European publications or in those of the Far East. The number last noticed concluded with the Paiwans, the tribe with which the Dutch came in contact in the seventeenth century, during their temporary occupation of part of Formosa, and of which therefore we had the most information. The present instalment deals with several other tribes, including one very peculiar and hitherto unknown people, the Caviangans, who are comparatively few in number, inhabiting lofty mountains, and having many superstitions with regard to hills and the spirits which inhabit them. We have also an account of the Tipuns, the most powerful tribe in southern Formosa, inhabiting the great plain inland from the headland marked Double Peak on the charts of the east coast. These have a tradition that they came from some other country hundreds of years ago, but they appear now to differ little from their neighbours the Paiwans. But there is one very radical distinction, viz., that when a man marries he enters his wife's family, whereas amongst the Paiwans the reverse is the case. Amongst them tattooing is a mark of rank, and is strictly prohibited to the commonalty. Another tribe described is the Amias. The Chinese class these as aborigines, but the true aboriginal tribes look on them as foreigners. They have a curious tradition of their origin, but the aborigines have the more prosaic one of shipwreck, and it appears that the Amias do not consider themselves entitled to equal social rank with the other savages. In appearance and customs they differ much from their neighbours, and worship one Supreme Being, not a multitude of spirits. They believe in an after state, dependent on personal conduct in this life, and they have a sort of purgatory amongst their beliefs. They have a vague notion of lands and peoples where communication is carried on by means of other than oral speech. This, says Mr. Taylor, is the only trace in South Formosa of any original idea of writing. Their explanations of certain natural phenomena, such as thunder and lightning, sunset and sunrise, are curious. Earthquakes they believe to be caused by a pig scratching itself against an iron bar stuck into the earth. This paper leaves on the mind, even more strongly than its predecessor, the impression that in the future Formosa will offer ethnological problems as interesting and complicated as any equal area on the earth's surface. It is clear, too, that all the divisions of the inhabitants of the island hitherto given by writers, whether Chinese or Europeans, are wholly incorrect and unscientific. There are wider differences amongst the tribes, and a far greater number of different tribes, than has ever been supposed. Moreover, it is obvious that in the present state of our knowledge of the tribes, it would be idle to theorise about them. Mr. Taylor, dealing only with a very small section in the south of the island, has described six or seven tribes; amongst these we find some calling themselves aborigines, and looking down as strangers and new-comers on others who have been generally supposed to be aborigines. In view of the wild and inaccessible nature of a large part of the eastern half of Formosa, and of the danger of entering it on account of the chronic state of war which exists between the natives and their Chinese masters, it must be a long time before a clear or trustworthy ethnological account of Formosa can be written. It is quite possible that some of the largest ethnological problems of the Far East may be involved in Formosa; the knot may, perhaps, lie there. Meantime, Mr. Taylor deserves thanks for his careful and interesting collection of new facts which are vital to the discussion of Formosan ethnology.

A REPORT addressed by Col. Fontana, the Governor of Chubut, to the President of the Argentine Republic, gives details of the exploration of Chubut up to the Andes lately made by the Governor. The Expedition, consisting of thirty men, left Raiwon, the chief town of Chubut territory, on October 14, and returned on February 8, having traversed about 1000 leagues in four months. It first followed the tortuous course of the Rio Chubut to its source in the Cordilleras, about the 42nd degree south latitude, the northern limit of Chubut, and then, c ossing well-watered and fertile prairies and enormous forests, reached the 46th parallel. It discovered three passages into Chili, and laid down accurately the courses of several rivers heretofore fixed by guess-work. Col. Fontana believes he was the first to quench his thirst in the spring from which the River Senger takes its rise: he has removed the doubts which existed respecting Lakes Colne and Musters, and verified their positions; and he has determined the geographical position of the spots at which the Senger and Chico debouch into the lake. He promises in a short time to have completed maps which will correct many errors concerning the hydrography and orography of this region.

WE have received the annual report for 1885 of the Russian Geographical Society, which contains short accounts of the expeditions of M. Prjevalsky to Central Asia, M. Potanin to China, M. Grum-Grzimailo in the sub-Pamir region, MM. Wolter and Trusman ; and the usual notices on works for which the medals of the Society were awarded. Geographers surely will be sorry not to find in this report any notice of the work done by the Caucasian and Siberian branches of the Society, which usually so greatly increases the value of the annual report of the Russian Geographical Society.

WE are glad to learn from the last Annual Report of the Russian Geographical Society that the Appendix to the *Russian Gazetteer*, by P. P. Semenoff, is in course of preparation. The full edition of the observations at the Polar Stations on Novaya Zemlya and on the Lena ; the remarkable collection of maps dealing with the delta of the Amu-daria, Baron Kaulbars ; and a geological map of the shores of Lake Baikal, are also in preparation.

AT the last meeting of the Paris Geographical Society, Dr. Maurel read a paper on his travels in Cochin China and Cambodia, on a mission from the Minister of Public Instruction. By means of a series of maps representing the Indo-Chinese peninsula in the seventh, eleventh, eighteenth, and nineteenth centuries, he showed the relative importance at different epochs of each of the peoples inhabiting this region. He then gave a general account of the country, its geography, climate, population, &c. A large collection of ethnographical objects which he had with him added much interest to that part of his paper. The young Cambodians at present being educated in Paris were present, clothed in the national costume.

THE DETERMINATION OF THE INDEX OF REFRACTION OF A FLUID BY MEANS OF THE MICROSCOPE

OF the various means adopted hitherto for the determination of the refractive index of a fluid, the most usually adopted has been that of the hollow prism, telescope, and collimator.

This method involves (α) the determination of the angle of the prism ; (β) the position of minimum deviation ; (γ) the use of monochromatic light, if errors arising from the different dispersive qualities of the substances are to be avoided. These preliminaries render the labour of determining the index a very difficult task, and the observer will scarcely expect to accomplish more than one observation at a sitting.

Cleaning the prism is not the least of the troubles, and when we add to them the fact that many liquids are so opaque that sufficient light can scarcely be passed through them for the observation, it is not surprising that so few have been found to possess the courage necessary for attacking the problem. The writer having had occasion for frequent determination of the index of refraction, has found the use of the microscope far surpasses the usual method in giving results of the greatest delicacy combined with a minimum of cost and of time.

Starting with the well-known fact, that an object viewed through a medium whose refractive index is different from that of air will occupy a different position from its image, or in the language of the text-books, $v = u + \frac{t}{\mu}$, where v determines the position of the geometrical focus of a pencil after direct refraction through a plate whose thickness is t, the writer was led to adopt the following plan.

On an ordinary "slip" as used for mounting preparations for the microscope a delicate mark is made with a writing diamond. A large but very thin "cover-glass" is cut in half, and its pieces cemented to the "slip" on either side of the mark, leaving a space of about one-eighth of an inch ; then, resting on these supports, and bridging over the intervening space, is placed a small but very thin "cover-glass," and a drop of the fluid to be examined is run under this.

The fine mark made on the "slip" is now viewed through this with the microscope, using as high a power as possible, for the higher the objective the more delicate will be its focal adjustment ; when the object is in focus the position of the "fine adjustment" must be read off. The microscope must then be left, and the slip removed for the examination of any other fluid. The top cover-glass is lifted off, the slip cleaned, the *same* cover-glass replaced, and a drop of a different fluid run under. Replacing now the slip upon the stage, and looking for the mark which was previously in focus, it will be found that an alteration of the fine adjustment is necessary to bring it into focus.

If the medium is of lower refractive index, the objective will have to be lowered, and conversely. Thus a rapid comparison of the relative refractive indexes of two media may easily be made.

But not only can the relative refractive powers of different bodies be thus obtained ; the absolute numerical values may with the greatest accuracy be determined. For this it is essential that the fine adjustment screw should have accurate micrometer divisions, and this is usually the case now that immersion objectives are in common use. Two fluids must be selected whose refractive indexes present a wide difference, say oil of cassia and water ; focus the mark, first viewed through water, secondly viewed through oil of cassia, and read off the number of divisions the screw has been turned through in the alteration of the focus. The refractive indexes of oil of cassia and water being known from the tables, a numerical value will by the formula be obtained for each division of the screw-head, and thus the absolute numerical index of any medium easily be determined.

By this simple and inexpensive method the writer has obtained from fifteen to twenty absolute indexes in a sitting of an hour's duration.

The importance of obtaining suitable media of high refractive index for mounting objects to be viewed with very high powers cannot be overestimated, for not only is a wider cone of light thus brought to bear upon the object, but its image is advanced, so that a greater working distance is obtained between the front lens of the objective and the cover-glass.

GORDON THOMPSON

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The twentieth annual report of the Museums and Lecture-Rooms Syndicate, lately issued, recounts continuous progress in many scientific departments. The number of students attending demonstrations in the Cavendish Laboratory reached 100 last winter, and during the year twelve persons have done original work in the Laboratory.

The Plumian Professor (Mr. G. H. Darwin) introduced a new feature last summer by giving a course of lectures in the Long Vacation, and the attendance (thirteen) was encouraging. Few students attend the Plumian Professor's advanced lectures on the orbits and perturbations of planets.

In mechanism Prof. Stuart reports that the temporary museum and lecture-room has become very insufficient.

In chemistry there has been a considerable increase of students in advanced classes and special departments. The new laboratory is now being vigorously advanced. The classes in mineralogy maintain an average of sixteen students. The acquisition of 250 specimens from Mr. Field's collection has added some minerals previously unrepresented, and has improved the collection considerably for students' use.

In geology Prof. Hughes regrets the disadvantages of his present accommodation for teaching and lecturing, and finds the specimens of value are lost to the Museum because of its inadequate means of displaying them. A valuable collection of Cretaceous Cambridge fossils, many of them type-specimens, has been presented by Mr. James Carter of Cambridge.

Mr. Marr, Fellow of St. John's College, is engaged upon the arrangemext of the Foreign and British Cambrian fossils, of which it will be desirable soon to publish a new catalogue. The petrological series has been rearranged, and also the collection of microscope slides. The Upper Jurassic fossils have been largely added to and rearranged. Many interesting additions to the museum are chronicled in the report. It shows how largely the Museum gains from the interest of present and former students at Cambridge.

Prof. Babington has been chiefly occupied with the study of different parts of the Herbarium—especially the magnificent collection of European Rubi—and the identification of plants sent by botanists from a distance. Dr. Vines's students have numbered nearly sixty, and the Botanical Laboratory is inconveniently crowded. The commencement of a botanical museum has been made by Messrs. Potter and Gardiner, with the object of illustrating the ordinary text-books in the hands of students. Many interesting specimens have been given by Sir Joseph Hooker and Mr. Thiselton Dyer, Messrs. Potter, Vines, Gardiner, Hillhouse, and Miss B. K. Taylor of Girton College.

In the Museums of Zoology and Comparative Anatomy some most useful work has been done by the Strickland Curator (Mr. Gadow) in exhibiting the characteristic parts of birds, labelled and illustrated by printed descriptions. A lecture-room for animal morphology is urgently required. The attendances in the Lent Term this year were:—Elementary Biology, 163; Elementary Morphology, 94; Advanced Morphology, 16; total 273. Besides the two lecturers, nine graduates and advanced students took part in demonstrating to the classes. Prof. Macalister reports that the new iron dissecting-room has been very satisfactory, and far more anatomical work has been done than ever before in the University.

The number of students in the elementary physiology classes have averaged 130 each term; while an average of over 30 attended advanced lectures. In pathology Prof. Roy has given systematic lectures on general pathology, a demonstration course on morbid anatomy, a practical pathology course, morbid histology classes, &c., and has found it necessary to engage Mr. Joseph Griffiths, M.B. Edin., as his assistant. Space and other accommodation being deficient hampers the extension of the work.

Vigorous work in natural science will go on during July and August. Mr. Fenton will give a course of chemistry, and the University and Cavendish Laboratories will be open. Mr. Potter will lecture on systematic botany with practical work. Repetition classes in histology and physiology will be given by a demonstrator, and Dr. Hill will conduct a class for practical histology. Prof. Macalister will give demonstrations in osteology; and other lectures will be given regularly in connection with the medical school by Prof. Humphry, Prof. Roy, Dr. Anningson, Dr. Ingle, &c. The courses will begin from July 7 to 12.

Mr. W. H. Caldwell, Fellow of Caius College, and Balfour Student, having returned to Cambridge from Australia with a large supply of valuable material, asks for a room in which to prosecute his original researches. This it is proposed to supply at a cost of 110*l*. on the roof of a portion of the Museum Buildings.

SCIENTIFIC SERIALS

American Journal of Science, May.—The columnar structure in the igneous rocks on Orange Mountain, New Jersey, by Joseph P. Iddings. This paper, read before the Philosophical Society of Washington, June 1885, deals especially with the large vertical columnar formations of O'Rourke's Quarry south of Llewellyn Park, and with the still more interesting case of curving and radiating columns in the Undercliff Quarry near the north gate of the same park. These lava sheets are studied in connection with the general theory of columnar formation, which is attributed to a cracking produced by the shrinkage of the mass upon further cooling after it has consolidated into rock, which still retains a great amount of heat. As the consolidation due to surface-cooling proceeds inward, the resistance to contraction parallel to the surface increases at a greater rate than that normal to it, a point may then be reached where resistance in the first-named direction will exceed that in the second, and the resulting rupture will be *perpendicular* to the cooling surface. The wavy form of some of the columns in Orange Mountain suggests irregularities in the mass which disturbed the uniform advance of the lines of maximum strain, and caused them to deviate from parallelism.—Larval theory of the origin of tissue, by A. Hyatt. This is an abstract of a paper published in the *Proceedings* of the Boston Society of Natural History (1884), in which an attempt is made to trace a phyletic connection between Protozoa and Metazoa, and also to show that the tissue-cells of the latter are similar to asexual larvæ and related by their modes of development to Protozoa, just as larval forms among the Metazoa themselves are related to the ancestral adults of the different groups to which they belong. In the abstract the suggestion is added that Volvox and Eudorina are true intermediate forms entitled to be called Mesozoa or Blastrea. The author's conclusions bear directly on the results already obtained by Semper, Dohrn, and others in tracing the origin of the vertebrates to some worm-like type.—Cretaceous metamorphic rocks of California, by George F. Becker. During a recent investigation of the Californian quicksilver deposits by the United States Geological Survey, the crystalline and serpentinoid metamorphic rocks of the coast-ranges have been subjected to an elaborate examination. Pending a complete report, a summary of the results is given in the present paper, all detailed proofs being deferred until final publication. The field-work was carried out by the author and Mr. H. W. Turner, the chemical analyses by Dr. W. H. Melville; and the microscopical examinations jointly by the author and Mr. Waldemar Lindgren. The question of metamorphism has perhaps never before been studied under more favourable conditions: a solid basis has been obtained for further inquiry, while the results already secured are sufficiently definite to form an important aid for the investigation of metamorphic areas in other geological regions. One important result is the full confirmation of von Rath and Bischof's views regarding the probable conversion of feldspar into serpentine. There seems to be no doubt that the phenomenon occurs in the Californian coast-ranges where the feldspars are corroded externally, cracks widened irregularly and filled with serpentine, and in some cases elongated teeth of serpentine may be seen biting into the clear feldspathic mass. It is impossible to explain these and many similar occurrences, except on the supposition that a reaction between some fluid and the feldspars has yielded serpentine. Quartz also, which is well known to be sometimes converted into talc, is in the same region transformed into serpentine.—Arnold Guyot, by James D. Dana. This is a biographical sketch of the distinguished Swiss naturalist, brought down to the year 1848, when he settled in the United States.—On the determination of fossil dicotyledonous leaves, by Lester F. Ward. The writer offers some critical remarks on the views, and especially on the system of nomenclature, advocated by Dr. A. G. Nathorst of Stockholm in a paper on fossil floras recently published by him in the *Botanisches Centralblatt* (xxvi., 1886).—Pseudomorphs of limonite after pyrite, by Erastus G. Smith. It is shown that the common hydrated oxides of iron generally referred to limonite are undoubtedly alteration products of ferrous oxide, or decomposition-products of other iron-bearing minerals. Their secondary nature is clearly shown in the various occurrences where crystalline form is yet retained, giving clearly-defined pseudomorphs of ferric hydrate after the original mineral. An interesting case is described of such an alteration of pyrite into ferric hydrate, in which the crystalline form of the pyrite is sharply defined.—Influence of motion of the medium on the velocity of light, by Albert A. Michelson and Edward W. Morley. A series of important investigations are described, tending fully to confirm Fizeau's classical experiment of 1851, which proved that the luminiferous ether is entirely unaffected by the motion of the matter which it permeates.—Note on the structure of tempered steel, by C. Barus and V. Strouhal. The results are given of some experiments on the structure of steel, a full report on which will appear in *Bulletin* No. 35 of the U.S. Geological Survey.—Brookite from Magnet Cove, Arkansas, by Samuel L. Penfield. A description is given of a fine crystal of brookite from the collection of Prof. G. J. Brush. It belongs to the variety classed as arkansite by C. A. Shephard.

Bulletin de l'Académie Royale de Belgique, March 6.—Determination of the direction and velocity of the motion of the solar system through space, by M. P. Ubaghs. So far from being a constant quantity, the systematic aberration of the sun and its satellites was already shown to vary with time in right ascension and declination. It was also seen that, by taking into account this fact in studying the motion of the solar system, it might be possible to determine not only the direction and velocity of the motion, but also its extent and even the mean distance of the stars selected for the purpose of comparison. The author here undertakes to apply the principle to certain groups of stars of like magnitude, and although the results are not absolutely uniform, the agreement is sufficiently close to justify the conclusion that theory and practice are, on the whole, in harmony. The direction of the motion has been somewhat accurately determined, but the mean velocity expressed by the fraction 0·109 of the mean radius of the earth's orbit would appear to be far less than that usually attributed by astronomers to the motion of the solar system.—On the study of "arithmetical events," by M. E. Cesàro. In explanation of the expression "arithmetical events," this young and profoundly original mathematician remarks that the systems with which he is here occupied are constituted by numbers taken at hap-hazard. When such a system happens to enjoy a property capable of being stated in advance, it constitutes for him an event (*un événement*). By means of some extremely difficult and subtle analytical transformations he arrives at a very general and remarkable formula, by means of which he solves with the greatest ease a number of curious arithmetical problems, such as: "What probability is there that in any given division the most approximate quotient will be the quotient by default (*par défaut*)? What probability is there that, if an integer taken at hazard be divided by the sum of two other integers taken at hazard, the quotient by default will be an odd number?"—On the oxidation of hydrochloric acid under the influence of light, by M. Leo Backelandt. This paper deals with the phenomenon observed by the author, that concentrated pure hydrochloric acid exposed to the action of sunlight in a badly-stopped flask after some time turns yellow, and emits an odour of chlorine. The change is shown to be due to a process of oxidation, the atmospheric oxygen consuming the hydrogen of the hydrochloric acid and liberating the chlorine. Under analogous circumstances hydriodic acid acts in the same way, liberating its iodine.—Notes on the rocks of Kantavu Island, Fiji Archipelago, by M. A. Renard. The author deals mainly with the andesites of the port of Kantavu, where they assume a columnar disposition.—Examination of the objections made by M. Hirn against the kinetic theory of the gases, by M. R. Clausius. While admitting the general care and accuracy with which M. Hirn has conducted his extensive experiments, the author argues on theoretical grounds that they are in no way opposed to the now generally accepted kinetic theory.

Rendiconti del Reale Istituto Lombardo, April 15.—On the permanent magnetism of steel at various temperatures, by Dr. G. Poloni. In this paper, which is supplementary to the two memoirs published by the author in 1878 and 1882, several interesting experiments are described with a series of magnets subjected to the action of heat within the limits of 15° and 300° C.—Note on a new acid isomerous with aspartic acid, by Prof. G. Körner. The formula of this acid, which the author proposes to name α-iso-aspartic or α-amido-isosuccinic acid, is—

$$\begin{array}{l} CH_3 \\ | \\ C{-}CO_2H \\ \;\;{-}NH_2 \\ | \\ CO_2H. \end{array}$$

Rivista Scientifico-Industriale, April 15.—A new method of measuring the thermic expansion of solid bodies, by Prof. Filippo Artimini. The author describes an ingenious apparatus which he has constructed for the purpose of determining with sufficient accuracy the increase in the linear dimensions of solids, derived from the internal motion communicated to matter by thermic energy.

April 30-May 15.—On the real atomic heat of simple bodies in the mechanical theory of heat and the formulas relating to it, by Prof. Alessandro Sandrucci. In Hirn's "Mechanical Theory of Heat" the expression *real atomic heat* is applied to the product of the atomic weight *a* of a simple body by its absolute calorific capacity *K*, and it is shown that this quantity should be independent of temperature, and equal and constant for all existing simple bodies; but the deductions are established independently of any hypothesis on the nature of heat. Prof. Sandrucci now inquires whether, given a certain hypothesis on the nature of heat, and determining the physical concept of *real atomic heat* in said hypothesis, it might be possible to obtain general and numerical results equal, or very nearly equal, to those already found by Hirn.—On a new saponiferous plant, by Prof. G. Licopoli. To the *Saponaria officinalis*, the *Quillaja Saponaria*, and a few other plants of this class Prof. Licopoli now adds the *Enterolobium Timbouva*, Martius, which is widely diffused throughout South Brazil and Uruguay.

SOCIETIES AND ACADEMIES

London

Royal Society, May 20.—"On the Lifting Power of Electro-Magnets and the Magnetisation of Iron." By Shelford Bidwell, M.A.

If an electro-magnet be excited by a gradually increasing current, a limit is soon reached beyond which the ratio of increase of sustaining power to increase of current becomes rapidly smaller; and it has generally been assumed that this ratio continues to diminish indefinitely, so that an infinite current would not impart to a magnet much greater lifting power than that which it possesses when an approach to "saturation" is first indicated. Joule estimated that the attraction would never be as much as 200 lbs. per square inch of sectional area; and, much later, Rowland assigned 177 lbs. per square inch, or 12,420 grms. per square centimetre as the limit for iron of good quality.

Having reason to doubt these conclusions, the author made some experiments with an iron ring cut into two equal parts, each of which was surrounded by a coil containing nearly 1000 turns of insulated wire. When one-half of the ring was used as an electro-magnet, and the other half as an armature (no current being passed through its coil), the weight supported was with a current of 4·3 amperes 13,100 grms., and with 6·2 amperes 14,200 grms., per square centimetre of surface. The lifting power therefore exceeded that which had been previously considered the greatest possible; nor was there any indication that a limit was being approached. But it was of greater interest to observe the effects produced when *both* portions of the ring were brought under the influence of gradually increasing currents, the conditions then being nearly the same as in Rowland's experiments. It was found that when the magnetic force had reached 50 C.G.S. units, at which point the weight sustained was about 10,000 grms. per square centimetre, the falling off in the rate of increase of the lifting power was well marked. And it continued to diminish until the magnetic force was 250 units and the weight supported 14,000 grms. But from this point *the magnetising current and the weight that could be carried increased in exactly the same proportion*, and continued to do so until the magnetic force had been carried up to 585 units, when the experiment was stopped, the maximum weight supported having been 15,905 grms. per square centimetre, or 229·3 lbs. per square inch. Detailed results are given in the first and second columns of the table. A curve plotted with the magnetic forces as abscissæ, and the weights lifted as ordinates, becomes, when the magnetic force is greater than 240 units, a sensibly straight line inclined to the horizontal axis.

It occurred to the author that these results might be applied to the investigation of the changes of magnetisation which correspond to changes of magnetic force. For if W = the grms. weight supported per square centimetre, H = the magnetic force, and I = the magnetisation, then for the divided ring

$$Wg = 2\pi I^2 + HI;$$

and by giving to W and H the values found to correspond, it becomes possible to find corresponding values of H and I. These are contained in the first and third columns of the table. When H has exceeded about 200, the ratio of I to H no longer continues to diminish, and the curve expressing the relation between them apparently becomes a straight line. Were the experiment carried much further, a tendency to a limit would probably be indicated; but if there is one it must be considerably higher than it is generally believed to be.

If k denote the susceptibility, μ the permeability, and B the magnetic induction, then $I = kH$, $\mu = 1 + 4\pi k$, and $B = \mu H$. Hence the values of k, μ, and B corresponding to different values of H can be found, and are given in the table. The figures in the last two columns are of great interest. Rowland, in order to exhibit the results of his well-known experiments in the form of a curve which (as he believed) would be of finite dimensions, plotted the values of μ as ordinates against those of B as abscissæ. The curve of μ thus obtained, after reaching a maximum for B = 5000, fell rapidly and in an almost straight line towards the horizontal axis. Assuming that the line would continue to be straight until it actually met the axis, Rowland concluded that the maximum of magnetic induction was about 17,500 units.

Now the greatest magnetic force used in Rowland's experiments was only 64 C.G.S. units; the imaginary part of his curve, therefore, corresponds to values of H ranging from 64 to infinity. A part of this exceedingly wide gap is filled by the author's experiments, in which H reaches 585; and if the values of μ and B given in the table are plotted, the curve will be found (after a rapid descent) to *bend round* soon after the limit of Rowland's observations, ultimately becoming, when B = 19,8.0, almost parallel to the axis of B.

The generally-accepted ideas as to the limits of magnetisation and magnetic induction therefore need modification.

TABLE (*Abstract*)

H	*W*	*I*	*k*	*μ*	*B*
3·9	2210	587	151·0	1899·1	7390
5·7	3460	735	128·9	1621·3	9240
17·7	7530	1083	61·2	770·2	13630
30·2	9215	1197	39·7	500·0	15100
78	11550	1337	17·1	216·5	16880
208	13810	1452	7·0	88·8	18470
427	15130	1504	3·5	45·3	19330
585	15905	1530	2·6	33·9	19820

May 27.—"On the Relation between the Thickness and the Surface-tension of Liquid Films." By A. W. Reinold, M.A., F.R.S., Professor of Physics in the Royal Naval College, Greenwich, and A. W. Rücker, M.A., F.R.S.

Plateau, Lüdtge, and van der Mensbrugghe have investigated experimentally the relation between the thickness and surface-tension of thin films. None of these observers, however, have used films thin enough to show the black of the first order of Newton's colours. The authors have therefore made a careful comparison of the surface-tension of black films with that of coloured films, the thickness of which was from 10 to 100 times greater. The principle of the method is the same as that utilised in Lüdtge's experiments. The interiors of the films to be compared are connected, and the relation between their surface-tensions is deduced from measurements by which their curvature is determined. In the authors' experiments a cylindrical film was thus balanced against another, which, though sometimes cylindrical and sometimes spherical, was initially of the same curvature as itself. The necessity for this arrangement arises from the fact that the authors' previous observations have shown that a cylindrical film thins to the black of the first order more readily than one of any other form. The fact that small changes in the forms of cylindrical and spherical films, attached to two circular rings, convert them into unduloids or nodoids, renders the mathematical theory somewhat complicated, but other considerations have been made to give way to the necessity of obtaining films which readily yield the black.

Preliminary experiments were instituted to test the observations of Lüdtge and van der Mensbrugghe as to difference of surface-tension between two films, one of which had been formed more recently than the other. These experiments showed that when one of the films was kept thick by supplying liquid to its upper support (flooding), while the other was allowed to thin, a considerable apparent difference of surface-tension was obtained. Before, however, this could be accepted as a trustworthy determination of an actual difference of surface-tension, several possible sources of error had to be considered. Thus, experiment shows (1) that the fact that the thicker film displays the greater surface-tension cannot be attributed to any peculiarity of the apparatus or mode of thickening adopted; (2) that it is not due to the weight of the thicker film; and (3) that only a small part of the observed difference can be ascribed to any slipping of the film over the liquid attachments to the solid supports.

The cause of the phenomenon cannot at present be assigned with certainty. Perhaps many causes are at work. Reasons are given for the conclusion that it is merely an instance of the difficulty which many observers have found in preserving a liquid surface pure.

On the assumption that the rapid change in the surface-tension of a newly-formed film is not due to its thinning, but to a disturbing cause, attempts were then made to eliminate this cause, or reduce it so as to compare films of very different thicknesses.

Two methods of attacking the problem were carried out. In the first the procedure was as follows:—The diameters of two cylindrical films were measured when they were in the same state; an electric current was passed up one of them in order to thicken it; and then, after a sufficient length of time had elapsed for the direct effect due to the disturbance produced by the current to pass off, the diameters were again measured. By this means it was possible to compare two films, one of which was nearly all black, while the other displayed a little black and the colours of the first and second orders. Both films were then allowed to thin, and assuming (in accordance with previous observations of the authors) that that which was already black remained in a constant state, any change of diameter which took place, as the coloured film became black, could be observed.

In a second group of experiments a cylinder was balanced against a sphere. As a spherical film thins more slowly than a cylinder, a comparison between a thick film (sphere) and a black or partially black film (cylinder) could be made without having recourse to an electric current, and greater differences of thickness were obtained than in the earlier observations.

The differences of surface-tension measured in these observations were very small. They never exceeded 1·5 per cent., and the black films were sometimes more and sometimes less curved than the thicker films with which they were compared. There was no evidence of any regular change in the surface-tension as the thickness diminished, and the average difference between the tension of the black and coloured films as deduced from fifteen experiments was only 0·13 per cent.

The general result of the inquiry, therefore, appears to be that *when the black part of a soap-film forms in the normal way, spreading slowly over the surface, no evidence of any change in surface-tension dependent on the thickness of the film is furnished by a direct comparison of the tensions of thin and thick films over a range of thickness extending from* 1350 *to* 12 *millionths of a millimetre.*

This conclusion is based upon a method of experiment by which a change of ½ per cent. in the value of the tension must have been detected, had it existed, and upon fifteen independent comparisons of the tensions of black and coloured films.

The authors next discuss the bearing of their observations upon the question of the magnitude of the so-called "radius of molecular attraction." They point out that if the mere equality in the surface-tensions of thick and thin films is to be considered conclusive, they have accumulated much stronger evidence for the statement that the radius of molecular attraction is less than half the thickness of a black film, *i.e.* $< 6 \times 10^{-6}$ mm. than Plateau produced for the assertion that 59×10^{-6} mm. is a superior limit to its magnitude. They are, however, unwilling to draw this conclusion from their experiments until an explanation is forthcoming in harmony with it, of the apparent discontinuity in the thickness of the film which always (except under very special circumstances) occurs at the edge of the black.

They are themselves inclined to look upon the sharp edge of the black as evidence of a change in surface-tension due to the tenuity of the film, and to regard the result of their experiments as fixing a superior limit (0·5 per cent.) to the difference of the tension of the black and coloured parts.

As no explanation of the discontinuity at the edge of the black has (as far as the authors are aware) ever been put forward, they conclude by a suggestion which, though no doubt of a speculative character, may serve to draw attention to a subject which is they believe of considerable interest.

They show that the main facts to be accounted for, viz. the discontinuity, the uniform thickness of the black, the wide variations in the thickness of the part of the coloured film which is in contact with the black, and the equality in the surface-tensions of the black and coloured films, could be explained if it were supposed that the surface-tension has a critical value when the thickness is somewhat greater than 12×10^{-6} mm.

The possibility of the existence of such a critical value has been pointed out by Maxwell (*Encycl. Brit.*, art. "Capillarity"). It would be explained by the assumption frequently made in discussions on the nature of molecular forces, that as the distance between two molecules diminishes, the mutual force between them is alternatively attractive and repulsive.

June 10.—"On some New Elements in Gadolinite and Samarskite, Detected Spectroscopically." By William Crookes, F.R.S., V.P.C.S.

The recent discovery by my distinguished friend M. de Boisbaudran (*Comptes rendus*, cii., p. 1003, May 3, 1886) of the existence of a new element which he calls Dysprosium, makes it unadvisable on my part, as a fellow investigator in spectroscopic research, to delay any longer the announcement of some of the results I have obtained during the fractionations of the samarskite and gadolinite earths.

I will first take the earths which give absorption-spectra when their solutions are examined by transmitted light. These occur chiefly at the higher end, beginning with didymium and proceeding, through samarium, holmium, &c., to erbium, which is one of the least basic. The earths which give phosphorescent spectra chiefly occur at the lower end, but each group overlaps the other; for instance, yttria occurs above erbia.

One of the highest of the absorption-spectrum earths is didymia. The spectrum of didymium, as generally met with, is well known, and is given in my paper on "Radiant Matter Spectroscopy: Part 2, Samarium" (par. 135).

It has long been suspected that didymium is not a simple body, and in June 1885 Dr. C. Auer announced that by a series of many hundred fractional crystallisations he had succeeded in splitting up didymium into two new elements, one giving leek-green salts and the other rose-red salts. The green body he called Praseodymium and the rose-red Neodymium. I have not found that my method of fractionation gives a decomposition similar to this; probably didymium will be found to split up in more than one direction, according to the method adopted; but by pushing the fractionations at the didymium end of the series to a considerable extent, a change gradually comes over the spectrum. At the lower end the earth gives an absorption-spectrum such as is usually attributed to didymium, but with no trace of some of the bands in the blue end, the one at λ 443 being especially noticeable by its absence. The intermediate earths give the old didymium spectrum, the relative intensities of some of the bands varying according to the position of the earth in the series, the band 443 becoming visible as the higher end is approached. The highest fractions of all give the band 443 one of the most prominent in the spectrum, being accompanied by other fainter bands which are absent in the lowest didymium spectrum.

I now come to a branch of the subject which promises to yield results even more fruitful than those given by the examination of absorption-spectra: I refer to the spectra yielded by some of the earths when phosphoresced *in vacuo*. This method has been so fully explained before the Royal Society, in my papers on "Radiant Matter Spectroscopy," that I need not repeat it.

In my Bakerian Lecture on Yttrium (*Phil. Trans.*, Part 3, 1885) I described the phosphorescent spectrum of this earth, and gave a drawing of it. In the Samarium paper I gave a similar description and drawing of the samarium spectrum, and also described and illustrated some anomalous results obtained when yttria and samaria were mixed together. Under the conditions described in the paper a sharp and brilliant orange line made its appearance, which at that time seemed as if it belonged to the samarium spectrum, and was only developed in greater intensity by the presence of yttria. This explanation, however, did not satisfy me, and I called the line $\left(\lambda\ 609 = \frac{1}{\lambda_2}\ 2693\right)$ "the anomalous line," intending to return to it at the first opportunity. I have since further investigated the occurrence of this line, with more than usual good fortune in the extent and importance of the new facts thereby disclosed.

Systematic fractionation was carried on with the portions of the general series giving the strongest appearance of line 609, and it soon became apparent that the line closely followed samarium. The presence of yttria was not necessary to bring it out, although by deadening the brightness of the other bands it was useful, not seeming to affect the line 609. Several circumstances, however, tended to show that although line 609 accompanied samarium with the utmost pertinacity, it was not so integral a part of its spectrum as the other red, green, and orange lines. For instance, the chemical as well as physical behaviour of these line-forming bodies was different. On closely comparing the spectra of specimens of samaria from different sources, line 609 varied much in intensity, in some cases being strong and in others almost absent. The addition of yttria was found to greatly deaden the red, orange, and green lines of samarium, while yttria had little or no effect on the line 609; again, a little lime entirely suppressed line 609, while it brought out the samarium lines with increased vigour. Finally attempts to separate line 609 from samarium, and those portions of the samarskite earths in which it chiefly concentrated, resulted in sufficient success to show me that, given time enough and an almost inexhaustible supply of material, a separation would not be difficult.

But what was then practically impossible to me, restricted with limited time and means, Nature has succeeded in effecting in the most perfect manner. I had been working on samarskite, and many observations had led me to think that the proportion of band-forming constituents varied slightly in the same earth from different minerals. Amongst others, gadolinite showed indications of such a differentiation, and therefore I continued the work on this mineral. Very few fractionations were necessary to show that the body giving line 609 was not present in the gadolinite earths, no admixtures of yttria and samaria from this source giving a trace of it. It follows, therefore, that the body whose phosphorescent spectrum gives line 609 occurs in samarskite, but not in gadolinite; thus it cannot be due to samarium, yttrium, or a mixture of these two elements; the only other probable alternative is that the source of this line is a new element.

Chemical fractionation is very similar to the formation of a spectrum with a very wide slit and a succession of shallow prisms. The centre portion remains unchanged for a long time, and the only approach to purity at first will be at the two ends, while a considerable series of operations is needed to produce an appreciable change in the centre.

During the later fractionations of the gadolinite earths another set of facts, formerly only suspected, have assumed consistent form. The spectrum bands which hitherto I had thought belonged to yttria soon began to vary in intensity among themselves, and continued fractionating increased the differences first observed. It would exceed the limits of a preliminary note were I to enter into details respecting the chemical and physical reasons which lead me to the definite conclusions I now bring before this Society. More than 2000 fractionations have been performed to settle this single point. I will content myself with stating the results. The earth hitherto called yttria appears to be a highly complex body, capable of being dissociated into several simpler substances, each of which gives a phosphorescent spectrum of great simplicity, consisting for the most part of only one line.

Taking the constituents in order of approximate basicity (the chemical analogue of refrangibility) the lowest earthy constituent gives a violet band (λ 456), which I have reason to believe belongs to ytterbia. Next comes a deep blue band (λ 482); then the strong citron band (λ 574), which has increased in sharpness till it deserves to be called a line; then come a close pair of greenish-blue lines (λ 549 and λ 541, mean 545); then a red band (λ 619), then a deep red band (λ 647), next a yellow band (λ 597), then another green line (λ 564); this (in samarskite yttria) is followed by the orange line (λ 609) of which I have already spoken; and finally, the three samarium bands remain at the highest part of the series. These for the present I do not touch, having my hands fully occupied with the more easily resolvable earths.

In the *Comptes rendus* for April 19, 1886, M. de Boisbaudran announced to the Academy that M. de Marignac, the discoverer of Y*a*, had selected for it the name Gadolinium. In February last I gave a short note on the earth Y*a* (*Proc.* Roy. Soc., No. 243, February 1886, and NATURE, vol. xxxiii., p. 525) in which I described its phosphorescent spectrum (agreeing exactly with that given by Y*a* of M. de Marignac's preparation). Referring to my paper it will be seen that Y*a* is composed of the following band-forming bodies:—(451), (549), (564), (597), (609), (619), together with a little samarium. Calling the samarium an impurity, it is thus seen that gadolinium is composed of at least four simpler bodies. The pair of green lines (λ 541 and λ 549, mean 545), being the strongest feature in its spectrum, may be taken as characteristic of gadolinium: the other lines are due to other bodies.

A hitherto unrecognised band in the spectrum by absorption or phosphorescence is not of itself definite proof of a new element, but if it is supported by chemical facts such as I have brought forward there is sufficient *primâ facie* evidence that a new element is present. Until, however, the new earths are separated in sufficient purity to enable their atomic weights to be approximately determined, and their chemical and physical properties observed, I think it is more prudent to regard them as elements on probation. I should therefore prefer to designate them provisionally by the mean wave-length of the dominant band. In this I am following the plan adopted by astronomers in naming the minor planets, which are known by a number encircled by a line. If, however, for the sake of easier discussion among chemists a definite name is thought more convenient, I will follow the plan frequently adopted in such cases, and provisionally name these bodies as shown in the following table:—

Position of lines in the spectrum	Mean wave-length of band or line	Provisional name	Probability
Absorption-bands in violet and blue	443	Dα	New.
	451·5	Sα	Dysprosium.
	475	Sβ	New.
Bright lines in—			
Violet	456	Sγ	Ytterbium.
Deep blue	482	Gα	New.
Greenish-blue (mean of a close pair	545	Gβ	Gadolinium.
Green	564	Gγ	New.
Citron	574	Gδ	New.
Yellow	597	Gε	New.
Orange	609	Sδ	New.
Red	619	Gζ	New.
Deep red	647	Gη	New.

The initial letters D, S, and G recall the origin of the earths respectively from Didymium, Samarskite, and Gadolinite.

Geological Society, May 26.—Prof. J. W. Judd, F.R.S., President, in the chair.—John Allen Brown was elected a Fellow of the Society.—The following communications were read:—Further proofs of the pre-Cambrian age of certain granitoid, felsitic, and other rocks in North-Western Pembrokeshire, by Henry Hicks, M.D., F.R.S., F.G.S. In this paper the author gave the results obtained by him during a recent visit to North-West Pembrokeshire. He stated that he had further examined some of the sections referred to in his previous papers, as well as others not therein mentioned, and that he had obtained many additional facts confirmatory of the views expressed by him in those papers. The Lower Cambrian conglomerates and grits, he said, contained pebbles of nearly all the rocks in that area which he had claimed as of pre-Cambrian age; and the fragments of the granitoid rocks, the felsitic rocks, the hälleflintas, and of the various rocks of the Pebidian series which he had found, showed unmistakably that those rocks had assumed, in all important particulars, their peculiar conditions before the fragments were broken off. Moreover, he stated that there was abundant evidence to show that the very newest of the pre-Cambrian rocks of the area had been greatly crushed, cleaved, and porcellanised before any of the Cambrian sediments were deposited; hence he maintained that there was in the area a most marked unconformity at the base of the Cambrian. At Chanter's Seat, near St. David's, he found that the Lower Cambrian grits and conglomerates were, in parts, almost wholly made up of fragments of characteristic varieties of the granitoid rocks which form the Dimetian ridge near by. The so-called granite of Brawdy, Hayscastle, and Brimaston, he said, there was good evidence to show, was probably of the age of the granitoid rocks of St. David's. The mass of so-called granite near Newgale, he stated, was composed of rhyolities and breccias, undoubtedly of pre-Cambrian age. The Roch Castle and Trefgarn rocks, he stated, could not possibly be intrusive in Cambrian and Silurian strata, but belonged to a series of pre-Cambrian rocks. He referred to the important evidence bearing on the age of these rocks given in a paper communicated to the Society, since his last paper was read, by Messrs. Marr and Roberts. These authors showed that in a quarry near Trefgarn Bridge a Cambrian conglomerate, overlain by Olenus-shales, is to be seen resting on the eroded edges of the Trefgarn series. The author examined this section lately, and obtained from the conglomerate some very large pebbles of the characteristic rocks called hälleflintas, and of the ash-bands, both of which are found *in situ* in the quarry. He therefore maintained that there was the most ample evidence to show that there was a great group of pre-Cambrian rocks exposed in North-West Pembrokeshire, and hence that he had proved conclusively that Dr. Geikie's views in regard to these rocks, as given in his paper and more recently in his text-book, are entirely erroneous.—On some rock-specimens collected by Dr. Hicks in North-Western Pembrokeshire, by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S. The author stated that he had examined microscopically a series of specimens collected by Dr. Hicks, and compared them with those described by Mr. T. Davies, in vol. xl. of the *Quarterly Journal*, and with some in his own collection. He agreed with Mr. Davies's conclusions in all important matters. The Chanter's Seat conglomerate contained many grains of quartz and felspar, curiously like those minerals in the so-called Dimetian, together with numerous small rolled fragments, about a quarter of an inch in diameter, exactly resembling the finer-grained varieties of that rock, besides bits of felsite, similar to some which occur in the St. David's district, quartzite, a quartz-schist, and an argillite. The rocks *in situ* in the Trefgarn quarry were indurated trachytic ashes, together with the curious flinty rock which was the most typical of the so-called hälleflintas. One of the pebbles from the overlying conglomerate perfectly corresponded with the last-named rock; others appeared to be most probably from an altered trachytic ash, differing only varietally from those *in situ*. After prolonged examination of this "hälleflinta" of Trefgarn and the similar rocks from Roch, he was of opinion that while it was possible that some specimens might be altered ashes, most of them were originally rhyolites or obsidians, devitrified, and then silicified by the passage of water which had contained silica in solution. The Trefgarn group obviously could not be intrusive in the Lower Cambrian, and it was extremely improbable that the Roch Castle series was newer than the basement conglomerate of that district. The Brawdy granitoid rock might be a granite, but at any rate it presented considerable resemblance to the "Dimetian." It was therefore evident that the Cambrian conglomerate of St. David's was formed from a very varied series of rocks, some of them much older than it, and that the Dimetian could not be intrusive in it. Moreover, even if the Dimetian should be proved ultimately to be a granite, and the core of a volcano which had emitted the rhyolites, sufficient time must have elapsed after its consolidation and prior to the making of the conglomerate to remove, by denudation, a great mass of overlying rock. Hence, whatever its nature, it was pre-Cambrian.—On the glaciation of South Lancashire, Cheshire, and the Welsh border, by Aubrey Strahan, F.G.S., H.M. Geological Survey. By permission of the Director-General. The author stated that it may be concluded that (1) the striæ on the English and Welsh sides respectively, while showing variations among themselves, by a marked preponderance in one quarter of the compass, indicate a direction of principal glaciation, this direction being on the English side from about N.N.W., and on the Welsh from about E.S.E. (2) The direction of glaciation in both districts agrees very closely with that of the transportation of the drift, but is only locally influenced by the form of the ground. (3) The striæ are by no means universal, but are found almost exclusively in connection with those beds in the drift which contain evidence of the actual presence of ice. The striæ are not such as can have been produced by valley-glaciers; they go across and not down the valleys, nor are there any moraines. The marine origin of the drifts is indicated by their well-marked stratification as a whole, by the alternations of well-washed sands and gravels with the Boulder-clays, and by the occurrence through all the beds of marine shells.

Royal Microscopical Society, May 12.—The Rev. Dr. Dallinger, F.R.S., President, in the chair.—The President referred to the death of Dr. J. Matthews, a member of Council, and a resolution of sympathy and condolence with the family was adopted.—Mr. J. Mayall, jun., exhibited and described a new pattern of the radial microscope by Mr. Swift, in which a rack was added to the arc, and a removable mechanical stage provided by which the object was clipped without any intermediate plate.—Mr. J. D. Hirst's communication was read referring to the report in the *Journal* of the Royal Society of N.S. Wales, attributing to him the view that a highly refractive mounting medium enabled objectives of small aperture to compete in resolution with wide-angled oil-immersion objectives. Mr. Hirst explained that the report was so worded as to convey a totally erroneous impression of what he claimed, which was only that the highly refractive medium would render difficult test diatoms so easy to a good high-angled water lens that the superiority of the oil-immersion objective will not be apparent, except under the very deepest eye-pieces.—Mr. C. D. Ahrens's paper, on a new polarising prism, was read; also Prof. Thompson's letter in commendation of it as unrivalled for use as a polariser, having flat ends, wide angle, and absence of distortion or coloured fringes.—Dr. Sternberg's paper on *Micrococcus pasteuri* was read, in which he called attention to the characters which distinguish it in a very definite manner from the microbe of fowl-cholera, it differing from the latter, not only in its morphology, but in the fact that it is not fatal to fowls.—Mr. F. H. Evans exhibited some photomicrographs produced by the Woodburytype process from negatives by himself, and transferred to glass for lantern illustration. They were shown upon a portable screen by Mr. G. Smith of the Sciopticon Co. Mr. Evans claimed that he had been more than ordinarily successful in overcoming the chief difficulty in the matter, that of obtaining such a focus as would properly represent the various planes of even deep objects, and this without loss of natural effect. The objects illustrated comprised Diatoms and Desmids, Foraminifera, Polycystina, star-fishes, sections of Echinus spines, insect preparations, animal parasites, and anatomical and vegetable sections, the remarkable clearness of most of the photographs calling forth frequent favourable comments from the Fellows present.

Entomological Society, June 2.—Mr. R. McLachlan, F.R.S., President, in the chair.—The following gentlemen were elected Fellows, viz. Mr. C. Baron-Clarke, M.A., F.R.S., Mr. Dannatt, Mr. H. Wallis-Kew, Mr. J. P. Mutch, Mr. B. W. Neave, Mr. A. C. F. Morgan, and Mr. W. Warren, M.A.—Mr. Stevens exhibited an example of *Heydenia auromaculata*, from the Shetlands, a species new to Britain.—Dr. Sharp exhibited certain specimens of *Staphylinidæ*, specially prepared and placed in cells of cardboard, sealed up with layers of bleached shellac.—Mr. Billups exhibited *Meteorus luridus*, Ruthe, a species of *Ichneumonidæ* new to Britain.—Mr. W. White exhibited cocoons of *Cerura vinula*, and made some observations as to the mode by which the perfect insect escapes from these solid structures. He thought that formic acid secreted by the insect was a probable factor in the operation. The question of how the parasitic *Ichneumonidæ* and *Diptera* escaped from these cocoons was also raised, and the President, Baron Osten-Sacken, Mr. Waterhouse, and Prof. Meldola, made remarks on the subject.—Mr. Elisha exhibited living larvæ of *Geometra smaragdaria*, from the Essex marshes. He also exhibited the singular pupæ of *A. bennettii*.—Mr. Howard Vaughan exhibited a long series of *Peronea hastiana*, showing the innumerable varieties of the species. He also exhibited, on behalf of Mr. Sidney Webb, of Dover, an interesting series of *Cidaria suffumata*, and read notes on the varieties of this species, communicated by Mr. Webb. Mr. Jenner-Weir, Mr. Waterhouse, Dr. Sharp, Mr. Distant, and Mr. Stainton took part in the discussion which ensued.—Mr. A. G. Butler communicated a paper on new genera and species of *Lepidoptera-Heterocera* from the Australian region, in which 21 new genera, and 103 new species were described.—Dr. Baly communicated a paper on uncharacterised species of *Diabrotica*.

EDINBURGH

Mathematical Society, June 11.—Dr. R. M. Ferguson, President, in the chair.—Mr. Alexander Robertson discussed a problem in combinations.—Mr. John Alison gave a mnemonic for a group of trigonometrical formulæ.—Mr. A. Y. Fraser read a communication from Mr. George A. Gibson on integration by parts and successive reduction.

PARIS

Academy of Sciences, June 7.—M. Jurien de la Gravière, President, in the chair.—Remarks on the works of M. Jean Claude Bouquet, by M. Halphen. To this notice is appended a list of the scientific writings of the illustrious mathematician, who was born at Morteau, Franche-Comté, on September 7, 1819, and died on September 9, 1885.—A new method of determining the refractions of light at all altitudes by means of the known value of one alone (continued), by M. Lœwy. The formulas are here given by which various refractions may be found after one has been determined by the method already explained.—On the part played by Lavoisier in determining the unit of weight in the metrical system, by M. C. Wolf. The imperfect data contained in Delambre's "Base du Système Métrique" are here supplemented from fresh documents tracing the action of Lavoisier in determining the various standards of weight in the metrical system adopted by the French Government at the close of the last century.—Heat of combustion and formation of the sugars, hydrates of carbon, and allied polyatomic atoms, by MM. Berthelot and Vieille. By their new method the authors have at last succeeded in effecting complete combustion of the sugars by free oxygen, thereby correcting the determinations already obtained by Rechenberg with the chlorate of potash for mannite, dulcite, lactose, saccharose, cellulose, and some other substances.—Fresh observations on the ammonia present in the ground, by MM. Berthelot and André. In reply to M. Schlœsing's last note the authors deal with the interesting problems suggested by that chemist's remarks on the laws regulating the interchange of ammonia between the atmosphere and the earth.—On the atomic weight and the spectrum of germanium, by M. Lecocq de Boisbaudran. Under the induction-spark a fine specimen of this element received from M. Winkler yields a beautiful spectrum with remarkably bright blue and violet rays, with atomic weight 72·27. Germanium would therefore appear to lie, not between bismuth and antimony, as at first supposed, but between siljcium and tin, like the ekasilicium of Mendelejeff's classification. Winkler had fixed its atomic weight provisionally at 72·75.—Note on the age of the Pikermi, Mount Leberon, and Maragha fauna, by M. Albert Gaudry. The author's observations induce him to refer this geological epoch rather to the Middle than to the Upper Tertiary.—Researches on gelatine, by M. P. Schutzenberger.—Influence of the anæsthetic vapours on the living tissues, by M. R. Dubois. The paper gives a description of the action exercised by the vapours of chloroform, ether, sulphuret of carbon, and alcohol on the protoplasm of the animal and vegetable tissues. The action is regarded not so much as one of coagulation, as of substitution analogous to that obtained by Graham when studying the effects of ether, alcohol, &c., on the mineral colloidal hydrates.—Observations of the comet *c* (1886) made at the Observatory of Lyons with the Brunner six-inch equatorial, by M. Gonnessiat.—Note on the herpolhodie, by M. Hess.—Extension of the general law of solidification to thymol and napthaline, by M. F. M. Raoult. The figures 0·61 and 0·64, here determined for these two substances, approach as nearly as possible to 0·62 given by the author's general law of solidification announced some years ago.—On a visual illusion and the apparent oscillation of the stars, by M. H. de Parville. The phenomenon of the apparent motion of slightly illumined bodies in the midst of darkness is here associated with that of the apparent motion of the stars known to the Germans by the name of *Sternschwanken*.—Action of the hydrogenated acids on vanadic acid, by M. A. Ditte.—Action of the oxide of lead on the hydrochlorate of ammonia, by M. F Isambert. This reaction, which absorbs heat, is shown to be entirely analogous to a phenomenon of dissociation, and controlled by the ordinary laws of dissociation.—Note on the molybdate of cerium, by M. Alph. Cossa. The form of this substance prepared by different processes by the author and M. Didier, confirms the strict analogy of molecular structure between certain combinations of the metals of cerite and the corresponding combinations of calcium and lead.—Note on a new alloy of aluminium, by M. Bourbouze. This useful alloy, consisting of 10 parts tin and 100 aluminium, is white, and has rather a higher density (2·85) than the pure metal.—On the presence of cholesterine in some new fatty substances of vegetable origin, by MM. Ed. Heckel and Fr. Schlagdenhauffen.—On the presence of cholesterine in the carrot; researches on this direct principle, by M. A. Arnaud. The cholesterine yielded by the carrot contains: carbon, 83·90; hydrogen, 12·20; oxygen, 3·90. It is insoluble in water, but very soluble in boiling alcohol, in the sulphuret of carbon, chloroform, and oils. It thus differs little from animal cholesterine, and is absolutely identical with the substance derived by Hesse from the Calabar bean.—Note on piliganine, the alkaloid of Lycopodiacea from Brazil, by M. Adriau. The piligan plant, which yields this principle, is a lycopod closely allied to the European *L. Selago*, and probably the variety known in Brazil as *L. Saussurus*. The extract is a strong poison, soluble in water, in alcohol, and chloroform.—Researches on the vegetable development of the sugar beetroot, by M. Aimé Girard.—On the crystalline form of the pyrophosphates and hypophosphates of soda, by M. H. Dufet.—On anthophyllite, an orthorhombic amphibole with two prismatic cleavages, *m* (110) (*mm* = 125° about), and a third, *h'* (010), by M. A. Lacroix.—On the development of the elements of the gray cortical substance of the cerebral circumvolutions, by M. W. Vignal.—On a chronometer with magnetic coupling, by M. A. d'Arsonval. This is an apparatus constructed at the suggestion of M. Brown-Séquard for the purpose of determining the velocity of sensitive impressions transmitted through the spinal marrow in a normal or pathologic state.—Note on sacculine, by M. Y. Delage. The author replies to the objections recently urged by M. Giard against some of the results announced by him on the evolution of sacculine.—On the internal air of insects compared with that of plants, by M. J. Peyrou.—On the stratigraphic structure of the Sierra Nevada and Sierra de Ronda, South Spain, by MM. Ch. Barrois and Alb. Offret.—On the geology of the Central Tunisian region between Kef and Kairwan, by M. G. Rolland.—On the genus *Bornia*, F. Rœmer, one of the most charac teristic fossil plants of the Kulm and Upper Devonian formations, by M. B. Renault.

BERLIN

Physiological Society, May 14.—Dr. Kossel reported on experiments instituted by Dr. Raske in the chemical division of the Physiological Institute, under his superintendence, on the chemical composition of the brain of the embryos of horned cattle. The occurrence of definite chemical substances, for example, elastine, keratine, cerebrine, in altogether special tissues, made it appear desirable to establish whether, during the process of development, the chemical composition or the morphological structure was the primary. Seeing that the brain of the embryo was very lymphatic, the composition and quantity of the lymph, which saturated all tissues of the embryo, were first ascertained and subtracted from the collective mass. The values found in two brains were compared with the results of the chemical investigation of brains carried out a considerable time ago in the laboratory of Prof. Hoppe-Seyler. The investigation referred to had shown that the gray substance of the brain of full-grown cattle differed essentially from the white substance. The gray substance, in the first place, contained but very little cerebrine, probably none at all; the white substance, on the other hand, contained more than 9 per cent. of the dry material. The gray substance was further distinguished from the white by its less amount of cholesterine and its greater quantity of albumen and extractives. In the defect in cerebrine, in the small amount of cholesterine, and in the copious supply of albumen and extractives, the brains of the embryos of horned cattle held exactly the same position as did the gray substance of grown-up brains. It was only in the quantity of lecithine and of salts that the embryonal brains demonstrated any difference from the gray substance. The embryonal brain was, therefore, very essentially distinguished from the white substance—a phenomenon in harmony with the fact that in the embryonal brain medullated nerve-fibres were not met with.—Prof. Christiani handed in his book published last year, "Zur Physiologie des Gehirns," and added some statements in corroboration of the view there set forth regarding the power of seeing on the part of rabbits after complete extirpation of Munck's sphere of vision. Prof. Gudden and Prof. Luciani had also, he said, found animals which after such operations had yet the power of sight. He sharply defined the difference between Prof. Munk and himself by saying that the former maintained an animal *must* be totally blind after excision of the sphere of vision on both sides, whereas his own observations allowed him to take up the position only that an animal after such an operation *might* get totally blind.—Dr. Virchow communicated the results of the investigations carried out by Herr Canfield, in the Anatomical Museum, into the accommodation apparatus of a bird's eye. In order to get at a knowledge of the physiological process of accommodation in the highly developed bird's eye, the anatomical substratum required to be gained. The investigation brought to light, in point of fact, a very long series of differences in the arrangement and development of the different formations of the apparatus situate between cornea, sclera, lens, and iris, among the different species of birds, great horned owl, owl, starling, dove, goose, and others. These differences the speaker illustrated by drawings, but no physiological explanation of them had yet been arrived at.—Dr. Gossels had made experiments regarding the secretion of nitrates through the urine in men and birds (duck and fowl), the nutriment administered having been in every case the same, nitrates being in some instances given, and also in some instances not given. By these experiments it was demonstrated that, in the case of animals secreting uric acid, a large part of the nitrates that had been partaken was again excreted, but that a still larger part disappeared in the body. As to what became of these latter nitrates, the speaker was not disposed to set up any hypothesis.—Prof. Zuntz, referring to the latter point, observed that several years ago it had been noticed in his laboratory that, after partaking of nitrate of ammonia, animals exhaled free nitrogen. A part at least of the nitrates, therefore, in accordance with this observation, was decomposed in the body and reduced to free nitrogen.

STOCKHOLM

Geological Society, March 4.—Hr. C. W. Crongvirt gave an account of the formation of iron ochre in some little lakes in the province of Helsingland. The lakes drew their water from the surrounding iron-containing streams. The yellow ochre seemed to collect on the clay, and the brown on the sand-bottom of the lakes. A factory has been started for its utilisation.—Prof. W. C. Brögger gave an account of the Olenell zone of North America, maintaining that this zone, with its peculiar fossils, which in several instances seemed to be the original types for varieties subsequently appearing, did in America—as well as had been long known to be the case in Scandinavia—occupy a very low place in the geological strata below the true Paradoxide slate.—Hr. F. Tegræus gave an account of his studies of the glacial formations on the Island of Gothland, in the Baltic. He stated that blocks and drifts proved that the glaciers had first moved in a south-westerly and afterward in an easterly direction. He had never found true ridges on the island, but certainly shore-terraces and terminal moraines.—Hr. E. Svedmark exhibited a specimen of argyrodite sent by Prof. Norkenskjöld, which contains the newly-discovered element germanium.

BOOKS AND PAMPHLETS RECEIVED

"Habit in Education," by F. A. Caspari (Heath, Boston).—"Observaciones Magnéticas y Meteorológicas del Real Colegio de Belen," Julio-Setiembre, 1885 (Habana).—"Transactions of the Royal Irish Academy," vol. xxviii., "Science," part 22, "Alphabetical Catalogue of Earthquakes Recorded as having occurred in Europe and Adjacent Countries," by J. P. O'Reilly (Academy, Dublin).—"Plane and Spherical Trigonometry," by H. B. Goodwin (Longmans).—"Studies from the Biological Laboratory," vol. iii. No. 6 (Johns Hopkins University).—"First Lessons in Geometry," by B. H. Rau (Addison, Madras).—"History of the Royal College of Surgeons in Ireland," by Sir C. A. Cameron, (Fannin, Dublin).—"Journal of the Royal Microscopical Society," June (Williams and Norgate).—"Bees and Bee-keeping," part 10, by F. R. Cheshire (U. Gill).—"British Cage-Birds," part 10, by R. S. Wallace (U. Gill).—"Fancy Pigeons," part 10, by J. C. Lyell (U. Gill).—"A New Chapter in the Story of Nature," by C. B. Radcliffe (Macmillan).—"An Introduction to General Pathology," by J. B. Sutton (Churchill).—"The Elementary Principles of Electric Lighting," by A. A. C. Swinton (Lockwood).—"Journal of the Society of Telegraph-Engineers and Electricians," No. 61, vol. xv. (Spon).—"British Journal of Petrography," June, by J. J. H. Teall (Watson, Birmingham).—"The Aryan Maori," by E. Tregear (Didsbury, Wellington, N.Z.).—"Catarrh of the Upper Air-Tract," by Dr. S. Sexton (Vail, New York).—"The Terraces of Rotomahana," by F. Cowan (Brett, Auckland).—"A Visit in Verse to Halemaumau," by F. Cowan (Honolulu).—"Australia, a Charcoal Sketch," by F. Cowan (Greensburg, Pa.).—"Labour Differences and their Settlement," by J. D. Weeks (New York).—"Torpedoes for National Defence," by W. H. Jaques (Putnam, New York).—"City of Coventry Free Public Library, Report of Committee, 1885."—"Ichthyol und Resorcin," by Dr. P. G. Unna (Voss, Hamburg).

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