THURSDAY, MARCH 26, 1885

PRACTICAL PHYSICS

Practical Physics. By R. T. Glazebrook, M.A., F.R.S., and W. N. Shaw, M.A., Demonstrators at the Cavendish Laboratory, Cambridge. (London: Longmans, Green, and Co., 1885.)

THE authors have done a real service to all whose business it is to conduct classes in a physical laboratory by supplying them with a most excellent guide. Not only teachers, but students, will find this book invaluable.

The authors have for some time prepared manuscript notes for use in the laboratory, sufficient to enable a student to make the measurements described without that frequent necessity for supervision which is found when verbal instruction only has been given. Since such well tested notes form the main portion of this work, it is certain that the experiments which are described have been so frequently carried out that the details given are sure to correspond to the best arrangement in each case, and further, that all possibility of an oversight has been removed.

In many cases instruments used for the same purpose are so different in d tail that the authors were met by the difficulty of choosing whether to describe several forms or to be content with explaining the particular instrument used for each purpose at the Cavendish Laboratory. They have, in adopting the latter course, found one means of limiting an enormous subject. In another direction they have found a natural boundary—that between a book of theoretical and one of practical physics. The theory of the methods and instruments is not given at length, except in those cases where the text-books are not sufficiently explicit. Again, the whole range of practical physics is so extensive that choice had to be exercised as to what experiments should be included and what unavoidably passed by. The experiments selected in each subject are typical, and are such as "to enable the student to make use of his practical work to obtain a clearer and more real insight into the principles of the subjects; they include those which have formed for the past three years the course of practical physics for the students preparing for the first part of the Natural Sciences Tripos." It would be impossible to make a selection more exactly suited to meet the wants of an educational laboratory.

In the preface will be found the system employed at the Cavendish Laboratory for making a set ot apparatus go as far as possible with a large class. The subject is divided into sections, each requiring its own instruments; sometimes one, sometimes several, experiments belong to one section. When any section is assigned to a student, none of the instruments belonging to it are available elsewhere. The same system of division is employed in the text, no less than eighty-two numbered sections being the result.

The value of the book is much enhanced by the addition, at the end of each section, of the results of an actual experiment. These short statements are valuable in many ways. In the first place, they show how to enter results systematically, so that the meaning of the entry is obvious. Secondly, they show the probable degree of accuracy attainable, especially when more than one method of making the same determination is given. Thirdly, and this is perhaps the most important to the teacher, the series of numbers to be found enables any one to discover the proportions and sizes of the several parts of each piece of apparatus employed. An example taken from p. 420 will make this clear:—

"*Experiment.*—Determine the difference of potential between the two ends of the given wire through which a current is flowing. Enter results thus:—

		grms.
Mass of water	... ...	24·2
Water equivalent of the calorimeter	...	4·2
m	... ...	28·4
M (copper deposited in voltameter)...		·222

Total rise of temperature for each two minutes:—

$4°{\cdot}4 \quad 4°{\cdot}4 \quad 4°{\cdot}2 \quad 4°{\cdot}0 \quad 3°{\cdot}8$

T ... ... $24°{\cdot}8$

$E = 4{\cdot}36 \times 10^8 = 4{\cdot}36$ volts."

In this case there is no means of estimating the probable accuracy of the result, but the data are sufficient to enable any one who wishes to do so to reproduce exactly the instrument employed.

The chapter on physical arithmetic, in which errors, corrections, accuracy, and the manipulation of small quantities are treated, is of special value.

The chapter on the balance is very complete. Though perhaps the balance is the most important of all philosophical instruments, it is a question whether so much space as twenty pages should be devoted to it, where so much that is important is necessarily excluded for want of space. Students do certainly use the balance most blindly, and if its theory is not explained in a satisfactory manner in the text-books, this surely is the place to find it. Other subjects of which the usual accounts in the authors' opinions needed supplementing are measurement of fluid pressure, thermometry, calorimetry, and hygrometry.

The chapters on electricity and magnetism are treated in a different manner from the rest of the book, for what reason is not apparent. The precise and quantitative relations between mechanical, magnetic, and electrical units are to be found in almost every modern text-book, and so there would be no occasion to repeat definitions, &c., if the treatment of these last chapters was the same as that employed in the earlier ones. It is here perhaps more than anywhere that the authors had to exercise their choice of the most suitable, out of an almost endless variety of experiments, any one of which might well find a place. No one can find fault with the selection, yet it seems a pity that not a word is said about electrometers or indeed about statical electricity at all. Many will be disappointed in finding no account of the absolute determination of electromotive force by any of the methods of induction. The only method given depends on the measurement of the heat generated by a current, which of course involves a knowledge of the value of J, the mechanical equivalent of heat. This is the more to be regretted, as instructions for determining experimentally the value of J are not to be found in the chapter on heat. It is to be hoped that in another edition a few pages will be devoted to one or both of these essential measurements.

For a first edition the book is remarkably free from misprints, the only one discovered being the omission of a "π" in the denominator of the expression for the absolute capacity of a condenser (p. 480). C. V. B.

MALAYAN ANTIQUITIES

Alterthümer aus dem Ostindischen Archipel und Angrenzenden Gebieten. Herausgegeben von Dr. A. B. Meyer. (Leipzig, 1884.)

THE present sumptuous volume forms the fourth of the series being issued under the enlightened management of the Curator of the Dresden Zoological and Anthropological Museum. These costly publications, which could scarcely be undertaken without the active co-operation of the general administration of the royal artistic and scientific collections in the Saxon Capital, will, when completed, prove a great boon, especially to students of eastern antiquities, and of the progress of human culture amongst the peoples of Southern Asia.

This fourth part, so far complete in itself, will be found of great value in elucidating the civilising influences both of Brahmanism and Buddhism on the races of Further India and the Malay Archipelago. It comprises nineteen photographic plates in folio, four of which are exquisitely coloured, with explanatory text and a map devoted almost exclusively to this important subject. Thus we have here embodied at once a descriptive and illustrated record of the archæological treasures in the Dresden Collection, which serve to mark the progress of the arts in the Eastern Archipelago and neighbouring regions from the earliest historic period, that is, from the first contact of those lands with the Indian religious and artistic world.

The arrangement is thoroughly systematic and most convenient for purposes of reference and comparative study, objects in stone, metal, wood, porcelain, and allied materials being grouped separately, and dealt with in the order indicated. The four stone figures from Java, reproduced on the first two plates, show at once the advantage of this arrangement. Here we have on Plate I. a genuine Brahmanical Trimurti placed side by side with a full-breasted female figure of undoubted Buddhistic type; on Plate II. an unmistakable Brahmanical Siva, again contrasted with the representation in high relief of two men, who, from their devout attitude and other indications, are evidently of Buddhist origin. Taken collectively these two groups thus present a striking illustration of both streams of Hindu culture, by which the island of Java was successively flooded. On this point the Curator's remarks in the accompanying text are highly instructive:—

"The Hindu antiquities found in Java are either Brahmanistic, Buddhistic, or mixed. Brahmanism repeatedly occurs in its Sivaistic phase. Buddhism, pure only in Borobudur and Tyandi Mendut ('Veth,' Java, ii. 172), is found mixed with Sivaism, Sivaistic divinities sometimes surrounding images of Buddha (Leemans, 'Borobudur,' 444), Buddhistic figures at others encircling Sivaistic idols ('Veth,' ii. 103, 173), or else assuming monstrous forms, such as often characterise Brahmanical deities ('Veth,' ii. 96, and Max Uhle, 'Descriptive Catalogue in MS. of the Royal Ethnological Museum,' No. 1464)."

The greatest monuments of Buddhism appear to be concentrated mainly in the central parts of Java, while those of the Brahmanical cult are scattered round them in all directions. Extensive Brahmanical settlements had already been formed in the island long before the first arrival of the Buddhist missionaries, who, according to Dr. Meyer, made their appearance probably about the fifth century of the new era. The stupendous Buddhist temple of Borobudur, rivalling that of Angkor-Vaht in Camboja, is assigned to the eighth or ninth century. But no attempt has been made to determine the date of the earliest Brahmanical remains in Java or the other islands of the Archipelago. They cannot, however, be much more recent than the first century of the Christian era, and may possibly be some two or three centuries earlier. It is to be regretted that this point cannot be determined with some approach to accuracy, for it has obviously a most important bearing on the question of the migrations of the Indonesian races, and especially on the diffusion of the Malayo-Polynesian languages throughout the Indian and Pacific Oceans. Those writers, who are disposed to regard these as comparatively recent events, should at least bear in mind that there are practically no traces of Sanskrit or Prakrit elements either in Malagasy, or in any of the Eastern Polynesian dialects. Hence, if Malaysia be taken as the point of dispersion west to Madagascar, east to the South Sea Islands, the migrations must necessarily have taken place at some time before the spread of Hindu influences throughout the Eastern Archipelago.

However, the collection is not confined to Hindu subjects, and on Plate VII. are figured a large number of iron spear-heads, some of which are undoubtedly subsequent to the introduction of Islám in the thirteenth century. Many of these objects, which were found in Jokjokarta (Java), are of simple type, much corroded by rust, and no doubt of considerable antiquity. But others show distinct traces of damaskeening, an art unknown before the arrival of the Arabs, although now universally diffused throughout the Archipelago. The process, locally known by the name of *pamor*, consists in manipulating steel and iron by means of acids, the designs being inlaid by the priests (Pfyffer, "Sketches from Java," p. 32).

Conspicuous among the bronze objects is a magnificent lion's head of absolutely unique type and great size (compass round neck 34 cm., diameter 30 cm., weight 100 kilograms), apparently from Camboja, although first discovered in Java. This superb bronze, whose analysis yielded copper 92·49, tin 5·53, lead 1·40, cobalt and nickel 0·07, iron 0·12, total 99·61, is referred by Dr. Meyer to the flourishing period of Cambojan art as embodied in the monuments of Angkor Vaht, and would accordingly be some 600 or 800 years old. Front and side views are here given in half the natural size on two separate plates. From these it is evident that the lion is playing the part of a rakshasa or guardian to some Buddhist shrine, such as are found sculptured at Borobudur. Another rakshasa of a very different character is a wooden figure of Garudha from the island of Bali, reproduced by the new phototype process, which has already rendered such valuable services to the arts, and especially to archæology in Germany. Here Garudha is represented as a winged human figure bearing on his shoulders probably a Vishnu, of whom the legs alone, suspended in front, have been preserved. It is described as perhaps a Sivaitic representation from some Brahmanical temple in Bali, where Vishnuism and Sivaism are said to be intimately associated. The introduction of the Hindu cult into Bali, where it still holds its ground in the midst of Islám, is referred to the beginning of the fifteenth century. But the fair state of preservation of this wooden image bespeaks a much more recent date.

On the concluding plates are figured numerous designs of bronze drums or gongs from every part of the Archipelago and Further India. These instruments, which play so large a part in the social economy of the Indonesian and Indo-Chinese peoples, are here brought together for the purpose of elucidating the obscure and hitherto little studied history of their origin and diffusion throughout South-Eastern Asia. Those interested in the subject will find much instructive matter embodied in the accompanying text.

A word of thanks is also due to Dr. Max Uhle, the Curator's able assistant, not only for his general cooperation, but more especially for the great care he has bestowed on the map of the regions in question. On it are accurately indicated all the places in Malaysia where Hindu antiquities have at any time been discovered, or where monuments dating from pre-Muhammadan times are found. A. H. KEANE

OUR BOOK SHELF

The Antananarivo Annual and Madagascar Magazine, No. VIII. Christmas, 1884. (Antananarivo: Printed at the London Missionary Society's Press by Malagasy Printers.)

ALTHOUGH the previous number of this interesting periodical was, I believe, noticed in NATURE, I should like to call attention to the present issue, inasmuch as it is a token of the valuable scientific work which, amid great difficulties, is being bravely carried on by Christian missions in the sorely troubled island of Madagascar.

One of the editors of the *Annual*, the Rev. R. Baron, is an accomplished botanist, indefatigable in his efforts to explore the botany of his adopted home, and unwearied in his efforts to obtain materials for Mr. J. G. Baker and other workers at home; and his colleagues, no less than himself and his fellow editor, the Rev. J. Sibree, seem devoted to the double duty of teaching the Christian religion and civilisation to the Malagasy and of advancing our scientific knowledge of the strange land in which they are for the time being dwelling.

The present number, besides a spirited account of a Royal Kabary or coronation ceremony, contains valuable philological articles on the Malagasy pronouns, by the Rev. L. Dahle; on Malagasy dictionaries, by the Rev. W. E. Cousins; and on the want of new words in the Malagasy language and the way of supplying them, by the Rev. S. E. Jorgensen, the latter having a more than philological, indeed a personal, interest to scientific writers, who, like the Madagascar missionaries, are continually in "want of new words" and not always very judicious in their "way of supplying them." Articles on Malagasy superstitions, on the Sakaklava, and on Malagasy proverbs, contain much valuable matter for the anthropologist; while a paper on medical mission work, by a non-professional; an instructive critical exposure of a geographical fiction, by the Rev. L. Dahle; notes on natural history, by the Rev. R. Baron; a four years' record of rainfall, by the Rev. J. Richardson; and various notes, such as one recording the arrival, on Malagasy shores, of worn fragments of pumice-stone, supposed. o be from Krakatoa, complete the number.

The technical printing does great credit to the native printers, for, though one German quotation has gone a little wrong, the press errors are otherwise exceedingly few.

I feel sure that I may bespeak the sympathy of the readers of NATURE with the *Antananarivo Annual*, and that we may look forward with confidence to much scientific as well as other fruit from the continued labours of the editors and their *confrères*. M. FOSTER

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 Forms of Leaves

I HAVE read Mr. Henslow's letter with interest; and of course any criticisms from him are worthy of all attention. At the same time I may observe that as yet he has only seen what may be called an abstract of an abstract. A Friday evening lecture is scarcely the occasion to work out a special statement in detail; but he is apparently criticising not even my lecture itself, but merely an abstract of it. He commences by saying that it is "self-evident" that the size of the leaf is regulated mainly by the thickness of the stem. This may be, but, so far as I am aware, the importance of this consideration had not been previously pointed out. Having, however, first disposed of my statement as "self-evident," he proceeds next to deny it altogether, and quotes cases in which the size of certain leaves bore no reference to the thickness of the stem. With regard to these, however, I must observe that I was referring to leaf-area, and as Mr. Henslow does not mention the number of leaves his illustration is incomplete. Moreover, as he was dealing merely with an abstract of what I said, he does not recognise the qualifications to which, in the lecture itself, I called attention.

As regards holly leaves, Mr. Henslow denies my statement, and questions my explanation. With reference to the fact, I should have thought there was no question. It has been stated over and over again in standard works. Sir J. D. Hooker in the "Student's Flora," for instance, says that the leaves are spinous, adding, those on the upper branches often entire." This is entirely in accordance with my own experience. Next, as to the explanation. Mr. Henslow observes that it "seems to be attributing to the holly a very unexpected process of ratiocination." Surely, however, this would apply to any explanation, and in this world there must be some cause for everything. Mr. Henslow would not maintain that the pitchers of pitcher plants imply any process of ratiocination?

Mr. Henslow's next point is with reference to fleshy leaves, and he observes that, "Surely the usual explanation that it is this thick cuticle which prevents rapid exhalation is a better reason." A better reason for what? I was not speaking of the thickness of the cuticle but of the unusual development of the parenchymatous tissue.

Again, he questions whether "cut-up" leaves present a greater extent of surface in proportion to their mass, but surely he cannot seriously deny this.

Lastly, he doubts whether it is an advantage to water-ranunculi to have filiform leaves, because he saw a pond last summer which was dried up, and yet covered with a "carpet composed of the erect filiform branchlets of the cut-up leaves of *Ranunculus aquatilis*." But it does not follow that a plant placed in an abnormal situation should at once alter its habit, any more than an individual duck would lose its webbed feet because it was kept from water. Any one who will take an ordinary plant of *R. aquatilis* out of water will see at once that the leaves cannot support themselves.

I admit that my suggestions require more evidence than can be given in a single lecture, and I shall hope to develop them at greater length elsewhere; but in the mean time, though I think that Mr. Henslow's criticisms admit of answer, I am much obliged for his suggestions. JOHN LUBBOCK

Aurora at Christiania

ON the evening of March 15 an aurora appeared of unusual proportions for our part of the country. It was seen for the first time at 7.45, and then consisted of diffused and faint arches high on the northern sky. By degrees its sphere extended, and at 8.30 it reached the zenith. In this position—from the northern horizon to zenith—the phenomenon remained almost uninterrupted all the following time. The light was rather feeble, and in the beginning the motions were insignificant. But at 10 o'clock the peculiar blazing or undulating movement that is designated by the name of *coruscation*, began to be seen, and during four hours and a half at least the whole northern half of the sky was the theatre of this uncommonly violent chase of the luminous clouds. The culmination of the aurora happened at 10.30, when on the northern sky advanced a series of splendid streamers, the inferior points of which played in red and green. This radiance was only of short duration, and later there appeared in the north only arches more or less distinct; while on the higher parts of the heavens the chasing flames incessantly continued their playing. Still, so late as 14.30 saw the flames as far as to the zenith with unimpaired violence.

I may add that on this occasion I succeeded in what I myself, as well as other friends of the aurora, have tried before in vain, viz. *to get the aurora to make impression on a photographic plate.* I exposed in all five plates; of these four (for times of exposure of 2–4 minutes) without the least trace of action, but the fifth, which was exposed during $8\frac{1}{2}$ minutes, shows both a part of the horizon with a high church spire and a feeble representation of a portion of the aurora. I must, however, state that this portion in itself was but very feebly illuminated, and that at the time when the phenomenon developed the greatest power of light I was prevented from applying the camera.

The object-glass employed was: Voigtländer euroscope, No. 1; Schleussner's dry plates.

Also on the 16th, in the evening, 8.45 to 10, there appeared an aurora, but consisting essentially only of feeble fragments of arches rather low on the northern sky. The aurora has in recent times been astonishingly rare: here in Christiania, in the course of the whole winter, it has been observed on the following days:—September 14, 17, 24; October 14, 15; November 17; December 22; January 22; February 14, 16; March 12, 15, 16.

March 15 excepted, all these auroræ have been rather insignificant. SOPHUS TROMHOLT

Christiania, March 17

"Peculiar Ice Forms"

UNDER the above caption, several correspondents of NATURE have recently described and discussed the agglutinated filamentoid ice-crystals commonly extruded from unfrozen earth under suitable conditions of moisture and temperature. B. Woodd Smith records their occurrence in the Savoyan Alps (his language implying variety of the phenomena there), and attributes them to the linear expansion incident to congelation of capillary columns of water in a thin sheet of soil resting upon rock (vol. xxxi. pp. 5-6). W. alludes to such crystals in general terms, refers to a previous notice of similar phenomena, and (erroneously) allies them genetically to hoar-frost (*ib.*, p. 29). Dr. John Rae discusses distinct (but erroneously supposed similar) phenomena at length, and argues that the several strata of crystals are remnants of successive sheets of ice or snow (*ib.*, pp. 81-2). Mr. Smith then controverts Mr. Rae's explanation, maintains his own, and refers to several earlier communications in NATURE relating to filamentoid ice-crystals (*ib.*, pp. 193-4); and sebsequently he transmits a letter from John D. Paul, who has essentially repeated his own observations in the Alps (*ib.*, p. 264).

Now that it has become fashionable to revive forgotten records, it may be pointed out that these correspondents ignore the more valuable portion of the literature of their subject. Even in NATURE discussion of the fibrous ice-crystals extruded from moist earth, wet wood, &c., was epidemic fifteen years ago, and again ten years later, besides the sporadic cases of three years ago, as shown in the following bibliography:—

1870 Vol. I.	—C. Spence Bate	p.	556
,, ,,	—Mr. Pengelly	p.	627
,, Vol. II.	—T. G. Bonney, John Langters (*sic*)	pp.	141-2
1871 Vol. III.	—T. G. Bonney, John Langton	pp.	105-7
,, ,,	—T. G. Bonney	p.	288
1880 Vol. XXI.	—Argyll	p.	274
,, ,,	—R. Meldola	p.	302
,, ,,	—Argyll	p.	368
,, ,,	—O. Fisher	p.	396
1880 Vol. XXI.	—D. Wetterhan	p.	396
,, ,,	—L. Bleekrode	p.	444
,, ,,	—S. T. Barrett	p.	537
,, ,,	—Wm. Le Roy Broun	p.	589
,, Vol. XXII.	—John Le Conte	p.	54
,, ,,	—R. H.	pp.	145-6
1882 Vol. XXV.	—J. F. Duthie	p.	78
,, Vol. XXVI.	—H. Warth	p.	81

The second outbreak was practically terminated by the communications of Profs. Broun and Le Conte. The first of these gentlemen wrote from a locality in which the phenomena are readily observable, while the latter called attention to his own elaborate researches of thirty years before (*Proc. Am. Assn. Adv. Sci.*, iii. 1850, p. 20-34; *Phil. Mag.*, third series, xxxvi. 1850, pp. 329-42).

More recently (February 6, 1884) Prof. Schwalbe has placed before the Physical Society of Berlin the results of his observations upon filamentoid ice-crystals in the Harz. After thorough study he accepts Le Conte's views as to their genesis.

Prof. Le Conte's explanation (which is essentially identical with that subsequently offered independently by Prof. Broun) is as follows:—"Let us suppose a portion of tolerably compact porous and warm earth saturated with moisture, to be exposed to the influence of a cold-producing cause. The soil being an imperfect conductor of heat, only a very superficial stratum would be reduced to the freezing point. As the resistance to lateral expansion is less at the surface than it is at] a sensible depth below, the effect of the first freezing would be to render the apices of the capillary tubes or pores conical or pyramidal. The sudden congelation of the water, filling the conical capillaries in the superior stratum, would produce a rapid and forcible expansion, which, being resisted by the unyielding walls of the cone, would not only protrude, but *project* or *detach and throw out* the thread-like columns of ice, in the direction of *least resistance*, or perpendicular to the surface. This would leave the summits of the tubes *partially empty*—a condition essential to the development of capillary force. Under these circumstances capillary attraction would draw up warm water from beneath, which, undergoing congelation, would, in like manner, elevate the column of ice still higher; and thus the process would go on as long as the cold continued to operate on unobstructed capillaries, supplied with sufficient water from below. It will be remarked that this explanation makes the whole process of protrusion to take place in a stratum of earth of almost inappreciable thickness. It also presumes that the protruding force act[s] *paroxysmally*" (*Proc. Am. Assn. Adv. Sci.*, *op. cit.*, 30-31). He subsequently remarks (NATURE, *op. cit.*): ". . . In relation to the explanation of the phenomena, I have nothing to add to that given" above, "except in relation to *two points*, viz.: (1) that I did not sufficiently *emphasise* the importance of the fact that the water contained in the *capillary* tubes in the upper stratum of earth is cooled many degrees below the freezing temperature; and (2) that consequently the congelation would necessarily take place *paroxysmally*."

It may be pointed out also that the great majority of the correspondents, both recent and earlier, base their explanations upon isolated observations of phenomena rare in their localities. In reality the extrusion of filamentoid ice-crystals is even more common in certain localities than is indicated by Le Conte's papers and Broun's letter. Thus, in the cultivated fields of the Mississippi valley, during a cloudy day following an autumnal rain, with an air temperature just below freezing-point, the writer has seen a thin layer of soil elevated from one to three inches over fully four-fifths of the area visible from the road throughout a day's journey. Greater length is sometimes attained by the crystals. Within a week the writer has observed, along the roadsides just beyond the limits of Washington, many irregular patches and belts of straight or slightly curved filamentoid crystals, four, six, and even eight inches in height. They were sometimes highest where they supported the greatest weight of earth, leaves, twigs, or pebbles upon their summits. In one case a worn quartzite pebble $1 \times 1\frac{1}{2} \times 2\frac{1}{2}$ inches was hoisted on a slender tuft of icy needles six or seven inches long, fully two inches above the smaller neighbouring pebbles and the film of soil in which it had been imbedded.

While Le Conte's theory of the formation of the filamentoid crystals extruded from moist earth or wet vegetal stems is acceptable in a general way, repeated observation upon crystals apparently in process of development has convinced the writer that their growth is not paroxysmal. The effect of capillarity in the moist substance is to keep the bases of the icy filaments, or the lower side of the stratum formed by their agglutination, wet; and congelation of this film appears to be continuous.

W. J. McGee

U.S. Geological Survey, Washington, D.C., U.S.A., February 1

Four-Dimensional Space

Possibly the question, What is the fourth dimension? may admit of an indefinite number of answers. I prefer, therefore, in proposing to consider Time as a fourth dimension of our existence, to speak of it as *a* fourth dimension rather than *the* fourth dimension. Since this fourth dimension cannot be introduced into space, as commonly understood, we require a new kind of space for its existence, which we may call time-space. There is then no difficulty in conceiving the analogues in this new kind of space, of the things in ordinary space which are known as lines, areas, and solids. A straight line, by moving in any direction not in its own length, generates an area; if this area moves in any direction not in its own plane it generates a solid; but if this solid moves in any direction, it still generates a solid, and nothing more. The reason of this is that we have not supposed it to move in the fourth dimension. If the straight line moves in its own direction, it describes only a straight line; if the area moves in its own plane, it describes only an area; in each case, motion in the dimensions in which the thing exists, gives us only a thing of the same dimensions; and, in order to get a thing of higher dimensions, we must have motion in a new dimension. But, as the idea of motion is only applicable in space of three dimensions, we must replace it by another which is applicable in our fourth dimension of time. Such an idea is that of successive existence. We must, therefore, conceive that there is a new three-dimensional space for each successive instant of time; and, by picturing to ourselves the aggregate formed by the successive positions in time-space of a given solid during a given time, we shall get the idea of a four-dimensional solid, which may be called a sur-solid. It will assist us to get a clearer idea, if we consider a solid which is in a constant state of change, both of magnitude and position; and an example of a solid which satisfies this condition sufficiently well, is afforded by the body of each of us. Let any man picture to himself the aggregate of his own bodily forms from birth to the present time, and he will have a clear idea of a sur-solid in time-space.

Let us now consider the sur-solid formed by the movement, or rather, the successive existence, of a cube in time-space. We are to conceive of the cube, and the whole of the three-dimensional space in which it is situated, as floating away in time-space for a given time; the cube will then have an initial and a final position, and these will be the end boundaries of the sur-solid. It will therefore have sixteen points, namely, the eight points belonging to the initial cube, and the eight belonging to the final cube. The successive positions (in time-space) of each of the eight points of the cube, will form what may be called a time-line; and adding to these the twenty-four edges of the initial and final cubes, we see that the sur-solid has thirty-two lines. The successive positions (in time-space) of each of the twelve edges of the cube, will form what may be called a time area; and, adding these to the twelve faces of the initial and final cubes, we see that the sur-solid has twenty-four areas. Lastly, the successive positions (in time-space) of each of the six faces of the cube, will form what may be called a time-solid; and, adding these to the initial and final cubes, we see that the sur-solid is bounded by eight solids. These results agree with the statements in your article. But it is not permissible to speak of the sur-solid as resting in "space," we must rather say that the section of it by any time is a cube resting (or moving) in "space."

S.

March 16

The Action of Very Minute Particles on Light

The action upon transmitted light of very minute particles suspended in a transparent medium is very well known, thanks to the investigations of Brücke, Tyndall, and others, up to a certain point. That is to say, that white light, passing through varying depths of a medium with such particles more or less thickly interspersed, is known to emerge coloured yellow, orange, or red, according to the extent of the action in question. Wishing to illustrate this phenomenon experimentally, I employed a very dilute solution of sodium thiosulphate (hyposulphite), which was acidified with hydrochloric or sulphuric acid, and then allowed to stand, observing from time to time the appearances when examined by transmitted light. The solution mentioned is admirably adapted for the purpose, inasmuch as the precipitation of the sulphur proceeds gradually; and, according to the greater or less dilution at starting, the completion of the reaction can be spread over a long period of time, in some of my experiments occupying more than forty-eight hours. For a while no turbidity whatever is visible; then a faint opalescence makes its appearance, and these exceedingly minute particles grow gradually in size, remaining, however, quite uniformly suspended for a considerable period, until a dimension is reached which causes them to settle out of the liquid. In this way I observed with unfailing regularity, and in unvarying order, though with various degrees of rapidity, an extension of the series of colours, which, so far as I am aware, had not previously been noticed, or at any rate published. From orange, the tint passed successively through rose red, purplish rose, to a full purple; then by insensible gradations to a fine violet, blue, green, greenish yellow, neutral tint, &c.

The solution was contained in spherical or pear-shaped flasks, or in cells with flat and parallel sides. A solution which was strong enough to give well-marked yellow, orange, and red tints, was not well adapted for the subsequent stages, as it soon became white and opaque, so that the later colours were almost entirely masked. A half litre flask filled with a solution so dilute, that ten minutes or more elapsed after acidifying before opalescence was first visible, gave very feeble yellow and orange; the rose and rose-purple, though decidedly weak, reminded me in tint of the colours seen towards the upper margin of the recent sky-glows; but when the full purple, violet, and blue were reached, the colours were very strong and well marked. A gas or candle-flame, viewed through the solution, which was violet by transmitted daylight, appeared emerald green. After passing the blue stage, the colours through green and yellow were much weaker, until, as before mentioned, a neutral tint was reached. Beyond this, with such a dilution, nothing further could be satisfactorily observed; but by taking a much more capacious flask, and using a solution only one-half or one-third the former strength, faint orange and pink were again observed *after* passing the neutral point. And with these more dilute solutions, very strongly marked secondary effects were noticed after once passing the "blue stage." A distorted image of a window was formed in the flask, and while the bright portions appeared greenish, those parts where the dark bars of the framework fell, appeared of a fine crimson colour; after the neutral point had been passed, and the bright parts appeared pink, the dark portion of the image appeared a brilliant emerald green. In either of these stages a part of the solution transformed to a tall, but narrow glass cylinder, had not sufficient depth to show any perceptible colour when viewed by transmitted light, but placed on a dark background below a window, showed a crimson or green glow respectively when viewed at a certain angle, and a complementary glow when seen at a different angle (by raising or lowering the level of the eye, the cylinder remaining stationary).

With the solution in any given stage of development, the effect of increasing the depth of the column through which the light passed was to increase the saturation of the colour to a large extent, and to alter its tint (apparently in the direction of the less refrangible end of the spectrum) to a much smaller degree. That the colour observed at any given stage was owing mainly to the size of the individual particles rather than to their greater or less proximity, was shown by the fact that, on pouring away half or two-thirds of the contents of the vessel, and filling with water, the colour, although much thinner, was nearly of the same tint.

I am not able to give the proportion by weight of the salt in the solutions experimented with; but I think about one gramme or less to the litre will be found to give good results. One or two trials, however, would soon indicate the appropriate strength.

The character of the colours and the whole nature of the phenomena led me to infer that they were in all probability caused by the *interference* of light; but as I could not see my way to a *rationale* of the mode of action, I deferred publication in the hope that by further investigation their exact nature and true cause might be more clearly worked out. The description in last week's Nature (p. 439) of Prof. Kiessling's ingenious "cloud-glow apparatus," by which somewhat similar results have been obtained with steam and sal-ammoniac fumes, induces me to publish my own observations, in the hope that some more competent physicist and mathematician may furnish a satisfactory theoretical elucidation. Lord Rayleigh, I find, has carefully examined the properties of the light *reflected* from an acidified solution of thiosulphate; but its action upon transmitted light appears to have escaped his attention. While Prof. Kiessling's method affords an independent confirmation of the phenomena in question, the thiosulphate solution lends itself much more readily to a study of the successive phases owing to the slow and steady nature of the action and the ease with which, by altering the strength of solution and the depth of the layer interposed, the circumstances can be adapted to the most favourable observation of any portion of the series.

J. SPEAR PARKER

Fall of Autumnal Foliage

THAT the causes of the fall of autumnal foliage have been for some time removed from the *terra incognita* of the natural history of plants is clear from the fact that the threefold reason is given by Sir J. D. Hooker in so elementary a botanical work as his "Primer of Botany" (Macmillan). The cause assigned by Mr. Henslow in NATURE (vol. xxxi. p. 434) will be seen, on reference to the little work mentioned, to be only one of the causes which operate in nature. I may add that I have more than once verified the third reason assigned by Sir J. D. Hooker by experiments on young and old rhododendron leaves, and on leaves of other plants, for my botany classes, and have been surprised at the great difference in the weight of mineral-ash left by equal weights of calcined leaves from the same plant, according as they were culled at the beginning or the end of the season.

ALEXANDER IRVING

Wellington College, Wokingham, March 14

[We do not think that either our correspondent or the Rev. G. Henslow has seized the point of Mr. Fraser's letter. This was not an inquiry as to the *modus operandi* by which leaves fall from the plant—a phenomenon which, as Mr. Fraser points out, occurs in India as in Europe. The process is in fact as well understood as anything in the life of the plant. What, however, Mr. Fraser drew attention to was the cause of the *autumn periodicity* of the fall in the higher latitudes as contrasted with what takes place for example in India, where the leaves, as he states, "drop off *gradually* in batches." Neither Mr. Henslow nor Mr. Irving explain why when a traveller from the south reaches Alexandria he finds that "here trees first become deciduous." Leaves fall everywhere, but why north of Alexandria *en masse* in the autumn and south of it in continuous driblets?—ED.]

Human Hibernation

MY letter on the Hibernation of the Siberian mammoth has been followed by two others, extremely interesting, but dealing, I may say exclusively, with the question of human hibernation, and the evidence offered in support of it; this raises a very important consideration, concerning which I ask leave to offer a few remarks:—The "fact," as stated by Mr. Braid, is that credible persons witnessed the burial of a man in a state of sleep or torpor, and that the same man was dug up alive some months afterwards. Why should we not believe this? The answer is not an easy one, nor can it be given in few words, but is in great measure that the same kind of almost unimpeachable testimony is to be had for any number of astounding occurrences, and that if the testimony is to be believed in one case, why should it not be accepted in all others? why are we driven to be so mistrustful? On this I will only say a few words, as your space is so limited. We know that some 5000 or 6000 years ago there existed a people—the Accadians—who, in their cuneiform writings, have left the most complete account of their daily lives and doings. We learn that these men regulated almost every act by the predictions of magicians, astrologers, or one form or another of impostors. We see, therefore, that the world was even then divided into knaves and dupes. Now this has been clearly going on ever since, and probably for indefinite ages before. The knaves having begun as such, have, for the most part, but by no means exclusively, developed into honest, or partially honest, fanatics; the dupes have greatly developed their credulity; and the stage had been reached that an individual with a sane and healthy mind was, if he escaped death, held in such disfavour as to stand a very poor chance in the struggle for existence. The scientific and critical revival of late years has arisen, I believe, partly because life is more secure, and toleration more prevalent, the virtually diseased mental condition is allowed to recover itself. To apply these views to the explanation of the particular case in point above referred to, we must remember that the burial was performed by men, descendants of others wholly unscrupulous, magicians, tricksters, who had probably followed the same calling for ages, and acquired an hereditary skill in such deceptions. Those who have witnessed, as I have done, their marvellous feats—for instance, of the native Indian jugglers—cannot doubt but that the case described was at all events within their power.

Messrs. Maskelyne and Cook similarly can bewilder and defeat the closest "scientific" examination; and is it not obvious but that even here, in the centre of the civilised modern world, the most clumsy impostors are daily bewildering and befooling people who believe themselves to be the possessors of highly cultivated and healthy intellects.

C. K. BUSHE

Athenæum Club

Bos Primigenius

IN NATURE, March 12 (p. 451), a specimen of the jaw of this animal is referred to as having been exhibited at a meeting of the Royal Physical Society of Edinburgh, followed by the remark: "It is apparently the only specimen that had been seen in Britain." Its size is given as 18¼ inches in extreme length." I possess a perfect ramus of a jaw of this species, excavated near Ilford, Surrey, a few years ago, which is fully 21 inches in length in a straight line, and 28 inches measured along the outer curve. There are, I am informed, many specimens of the jaws of *Bos primigenius* in the national collection (presented by the late Sir Antonio Brady), from the same district as my specimen.

West Bank, York

JAS. BACKHOUSE

THE BRITISH ASSOCIATION AND LOCAL SOCIETIES

ON behalf of the recently-appointed Corresponding Societies Committee of the British Association, the President and Secretaries are now calling the attention of Local Scientific Societies to certain Rules of the Association adopted at the meeting of the General Committee in November last. It will be remembered that during the last few years the subject of the relation of Local Scientific Societies to the British Association has received considerable attention, and that an opinion has been strongly expressed that the Local Scientific Societies and the British Association might, without any considerable sacrifice of independence, usefully cooperate in facilitating the conduct of investigations into local phenomena such as are frequently undertaken by Committees of the Association.

With this purpose in view the Rules, of which we print a copy, have been prepared, and have now been finally adopted by the General Committee of the Association; and under these provisions a Corresponding Societies Committee has been appointed. To these Rules we would ask the earnest attention of the many local societies throughout the kingdom:—

"*Corresponding Societies*

"(1) Any Society is eligible to be placed on the List of Corresponding Societies of the Association which undertakes local scientific investigations, and publishes notices of the results.

"(2) Applications may be made by any Society to be placed on the List of Corresponding Societies. Application must be addressed to the Secretary on or before June 1, preceding the annual meeting, at which it is intended they should be considered, and must be accompanied by specimens of the publications of the results of the local scientific investigations recently undertaken by the Society.

"(3) A Corresponding Societies Committee shall be annually nominated by the Council and appointed by the General Committee for the purpose of considering these applications, as well as for that of keeping themselves generally informed of the annual work of the Corresponding Societies, and of superintending the preparation of a list of the papers published by them. This Committee shall make an annual report to the General Committee, and shall suggest such additions or changes in the List of Corresponding Societies as they may think desirable.

"(4) Every Corresponding Society shall return each year, on or before June 1, to the Secretary of the Association, a schedule, properly filled up, which will be issued by the Secretary of the Association, and which will contain a request for such particulars with regard to the Society as may be required for the information of the Corresponding Societies Committee.

"(5) There shall be inserted in the Annual Report of the Association a list, in an abbreviated form, of the papers published by the Corresponding Societies during the past twelve months, which contain the results of the local scientific work conducted by them; those papers only being included which refer to subjects coming under the cognisance of one or other of the various sections of the Association.

"(6) A Corresponding Society shall have the right to nominate any one of its members, who is also a member of the Association, as its delegate to the annual meeting of the Association, who shall be for the time a member of the General Committee.

" *Conference of Delegates of Corresponding Societies*

"(7) The Delegates of the various Corresponding Societies shall constitute a Conference, of which the Chairman, Vice-Chairmen, and Secretaries shall be annually nominated by the Council, and appointed by the General Committee, and of which the members of the Corresponding Societies Committee shall be *ex officio* members.

"The Conference of Delegates shall be summoned by the Secretaries to hold one or more meetings during each annual meeting of the Association, and shall be empowered to invite any member or associate to take part in the meetings.

"The Secretaries of each Section shall be instructed to transmit to the Secretaries of the Conference of Delegates copies of any recommendations forwarded by the Presidents of Sections to the Committee of Recommendations bearing upon matters in which the co-operation of Corresponding Societies is desired; and the Secretaries of the Conference of Delegates shall invite the authors of these recommendations to attend the meetings of the Conference and give verbal explanations of their objects and of the precise way in which they would desire to have them carried into effect.

"It will be the duty of the Delegates to make themselves familiar with the purport of the several recommendations brought before the Conference, in order that they and others who take part in the meetings may be able to bring those recommendations clearly and favourably before their respective Societies. The Conference may also discuss propositions bearing on the promotion of more systematic observation and plans of operation, and of greater uniformity in the mode of publishing results."

UNDERGROUND NOISES HEARD AT CAIMAN-BRAC, CARRIBEAN SEA, ON AUGUST 26, 1883

THE following letter describes certain underground noises heard on the day of the great eruption of Krakatoa, in a little island of the Carribean Sea, very near the antipodes of the Sunda Strait. It is possibly an interesting instance of propagation of sound through the whole diameter of the earth. I shall first translate the letter of my correspondent, then add some explanatory remarks:—

"South of Cuba, in 80° long. W., and 20° lat. N., the three little islands, Great Caïman, Little Caïman, and Caïman-Brac, are inhabited by a population of tortoise fishermen; there are also a life-boat station and Lloyd's agent. These islands are indeed in the path of the great cyclones of the Antilles, and they witness many shipwrecks.

"In the month of September 1883, as I was in the island Utila, near the coast of Honduras, we heard the first news of the great eruptions of Krakatoa, and talking about those tremendous cataclysms, I met Capt. Robert Woodville, who had just received a letter from the Caïmans; he told me what follows:—

"On Sunday, August 26, the inhabitants of Caïman-Brac were astonished by a noise like the rolling of a distant thunderstorm; the sky was fine, and they at first thought it was a skirmish between a Spanish cruiser and some Cuban smugglers. On the south side of the island nothing was to be seen; they ran across the island, and northward all was quiet too; no smoke nor ship was in sight. The cannonade still continued, and going back again they recognised that the noise came from underground. They were much afraid, and expected their island would soon subside in the sea, or be turned into a volcano. By degrees the detonations ceased, and their fears were quieted. But the phenomenon was not forgotten, and was still talked about when the first news of the Krakatoa eruption came. They made the remark that the Caïmans and Sunda Strait are nearly at the antipodes of each other, and the hypothesis of a correlation between the two phenomena was propounded. . . .

"(Signed) EDMUND ROULET"

I will not be too sanguine, and accept without criticism so abnormal a fact of the propagation of underground sounds from Krakatoa to the Caïmans through the whole mass of the globus; but I will try to show the reasons which tell in favour of such a bold hypothesis, and lead me to accept it provisionally. There are, it seems to me, plausible grounds for admitting that the subterranean noises heard at the Caïmans were the repercussion of the explosions of the great Krakatoa eruption:—

(1) These noises heard at the Caïmans did not come from one of the numerous volcanoes of Central America: if a great eruption had been known on the same day, the inhabitants of Caïman-Brac and Utila would have found out for themselves the co-relation between the two phenomena. From the nineteenth catalogue of C. W. C. Fuchs (*Mineral. Mitth. v. Tschermak*, vi. 185, 1884) we know of the following eruptions which happened in the summer of 1883. The Omotepec, an insular volcano in the middle of the lake Nicaragua, was in eruption on June 19, opening a new crater, and giving way to abundant lava streams; in the month of August the lavas were still burning. Cotopaxi (in the State of Ecuador) had at the end of August (the exact time is not given) a short, but very strong eruption, accompanied by violent earthquakes. I cannot, however, believe that a great eruption, with noises audible at a distance of 1100 to 2300 kilometres, would not have been better noted, if it had taken place on the same day as the great eruption of Krakatoa. This last event has been enough talked about over the whole world to call attention to such a coincidence if it had really existed.

(2) As to the explanation of the Caïman noises by an unnoticed submarine eruption in the vicinity, I have only to state that the great Antilles are not a volcanic region: the nearest volcanic regions are the Little Antilles and the west coast of Central America, both which are too far to allow such an interpretation of the noises heard at the Caïmans.

(3) The great eruption of Krakatoa on August 26 and 27, 1883, was accompanied by subterranean noises which were always described as resembling the rolling of cannon or of thunderstorm. The description from the Sunda Islands does not differ from that from Caïman-Brac.

(4) The subterranean sounds of the Krakatoa eruption have had an enormous intensity, and have been detected at a distance never heard of before. As is well known (*vide* NATURE, vol. xxx. p. 10), the explosions were heard over a circle of 30° radius, *i.e.* 3300 kilometres. It is indeed only the quarter of the length of the earth's diameter; if the hypothesis is true, we would have here a considerable extension of the propagation of the sound through the earth.

(5) Caïman-Brac lies very near the antipodes of Krakatoa. The exact position of Krakatoa is 105° 30′ E. long. and 6° S. lat.; Caïman-Brac, 79° 30′ W. long. and 19° 30′ N. lat. The antipodes of Krakatoa is also 4° 30′ more towards east, and 13° 30′ more towards south; it is in the middle of the United States of Colombia, on the Magdalena River, between the towns Antioquia and Tunja.

(6) The time at which the noises have been heard at Caïman-Brac corresponds sufficiently to what we know about the time of the eruption of Krakatoa. From the report of R. D. M. Verbeek (NATURE, vol. xxx. p. 10) the explosions of the volcano have been noticed in the Sunda Islands on August 26 and 27, and especially on the morning of the 27th. The noise reached its maximum at Buitenzorg on the 27th at 6.45 a.m.; at Batavia at 8.30; and at Telok-Betong at 10 o'clock. From the difference of longitude August 27, 8.30 a.m. at Batavia is the same time as August 26, 8.5 p.m. at Caïman-Brac. If we admit that the propagation of the sound through the 12,000 kilometres of the earth's diameter would take about one hour, the maximum detonations must have reached the Caïmans on August 26 at 9 p.m. Unfortunately the letter of Mr. Roulet does not give us the exact time of day at which the sounds were heard at Caïman-Brac; I have asked my correspondent to complete, if possible, his observation on that point.

I do not wait for the reply before publishing the present communication for the following reasons:—I believe it is very important to call attention without further delay to this fact, and to beg of the inhabitants of the coast and the islands of the Carribean Sea to collect all that can be remembered about these events; perhaps they heard also the noises described at the Caïmans, and they can confirm, or complete, or correct the observation given by Capt. Woodville.

In case the correlation between the noises at Caïman-Brac and the Krakatoa eruption would be ascertained, it would be a fact of uncommon interest which would equal and surpass the other astonishing phenomena to which the cataclysm of the Sunda Strait gave rise: the transmission of the atmospheric waves to the barometers of the whole earth, the propagation of the marine waves to the maregraphs of Europe and America, the crepuscular and auroral glows of the autumn of 1883, the solar corona of 1884 (which is still apparent, and can be observed every day in February and March, 1885), the abnormal polarisation of the sky (A. Cornu), &c., &c. F. A. FOREL

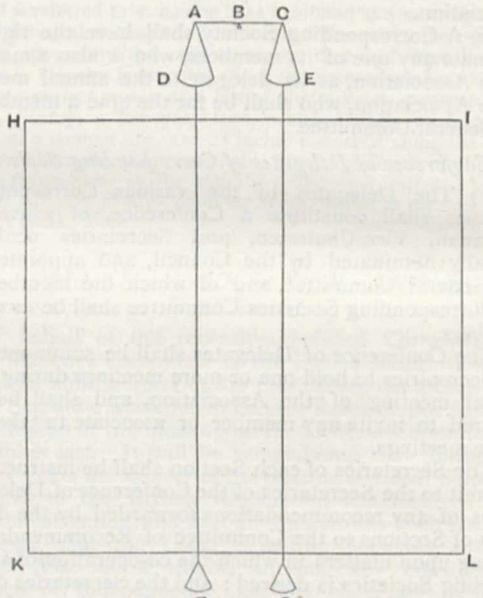
Morges, Switzerland, March 8

REMARKS ON OUR METHOD OF DETERMINING THE MEAN DENSITY OF THE EARTH

IN NATURE for March 5 (p. 408) Prof. Mayer suggests an improvement in our method of determining the mean density of the earth, from which it appears that our plan has not been properly understood. This misunderstanding, no doubt, has arisen from the incomplete description of our method given in the NATURE (Jan. 15, p. 260) report of the *Proceedings* of the Berlin Physical Society, which report was probably the only source of information accessible to Prof. Mayer. We are led therefore to give a short description of our method.

Let H I K L represent a section of a cubical block of lead, about two metres in the edge, and weighing 100,000 kilos. The balance A B C is placed in the middle of the upper horizontal surface. It bears the scale-pans D and E. Under these scale-pans the block is bored vertically through, and two other scale-pans, F and G, are suspended below the block, attached to the balance by means of rods passing through these openings.

A weight in D is brought into equilibrium by weights in G. The weight in D is acted upon by the earth's attraction + that of the block, and that in G by the earth's attraction − that of the block. The weights in G are then greater than that in D by twice the attraction of the block. The weight in D is now removed to F and counter-balanced by weights in E. The weight in E will be less than that in F by twice the attraction of the block. The difference of the two weighings gives therefore four



times the attraction of the block. A correction must be introduced for the variation in the earth's attraction due to the different heights of D, E, and F, G.

In order to obtain as great a deflection of the balance by the method suggested by Prof. Mayer, each of the mercury spheres must exert the same attraction as our lead block. This would require spheres having radii of about one metre. The length of the beam of the balance would be necessarily at least two metres. Besides each mass of mercury would exert some attraction on the weight on the other side, and thus lessen the deviation of the balance.

The method given by Prof. Mayer, except for the suggested employment of mercury, is then no improvement on ours. If we should use mercury, we would construct a cubical vessel to contain it, and use it as we propose to use the lead block. The advantage of using mercury is, however, counterbalanced by the difficulty of obtaining it in such large quantities as would be necessary. ARTHUR KÖNIG

FRANZ RICHARZ

Berlin, Physical Institute of the University, March 15

SATURN

IT is to be hoped that Continental observers may have been more favoured than ourselves with opportunities of scrutinising that grand display which has been for some time presented to us by this, the most wonderful of all the solar train. For more than one reason the almost unbroken persistence of that vaporous shroud which has long been investing our unfortunate sky is matter of especial regret. The broad development of that system in all its equally strange and beautiful detail;—its lofty culmination in our midnight heaven;—the probability that many who might look upon it now may never witness its return to a similar position of advantage—all find their place in the account. We can only now look for intelligence from other quarters, and hope that something more cheering may yet be in store for ourselves, before the advancing twilight steals away our opportunities; and that possibly, before these remarks meet the public eye, a change may have supervened to gladden the heart of the British observer.

Few of us, probably, would be likely to express ourselves as an individual once did, who, having for the first time seen Saturn through a good telescope, turned hastily away with a fervent aspiration that he might never see such a sight as that again! But the feeling that broke out in so grotesque a fashion is not altogether unintelligible. Many objects are more imposing in magnitude or brilliancy: none rival it in the impression of surprise. It is absolutely unique. Nothing else resembles it or approaches it in the whole visible creation. But this is not all. Our first impression of astonishment will be succeeded by the demands of a legitimate curiosity, and we shall begin to gaze upon that most charming combination of elegant outline and varied shading, not merely as a subject of admiration, but of close and careful study: we shall naturally inquire how far we understand what we are permitted to see, and how far that great mystery has been penetrated by the modern unrivalled extension of optical power. And here we may feel some disappointment when we are forced to admit that little corresponding advance in knowledge has waited on the increased means of investigation. There was an early dawn of hope and promise after the elder Herschel had shown what telescopes could do. Dawes, Lassell, Bond, De la Rue, Struve, not to mention others, at once overleaped all previous barriers, and showed how full that marvellous whole is, of not less surprising detail. But it is not encouraging to note how little progress, comparatively speaking, has been made of later years. With advantages so incontestably superior, what have we detected, on the whole, more than what passed before the attention of a previous generation? Take, for instance, the beautiful designs of De la Rue in 1852 and 1856; or the elaborate memoir of the observers at Harvard, published in 1857. What material progress have we to boast of? What further light have the same instruments, or others of greater power, thrown on the minute subdivisions of the rings, or the abnormal and inexplicable outlines of the shadow of the globe? On the contrary, with the exception of the radial streaks or notches figured by Trouvelot, the existence of which seems incompatible with the received idea as to the structure and rotation of the rings, how little can be mentioned, traces of which, to say the least, cannot be found even in very early records! The brilliant spot detected by Hall seems to have been in some measure anticipated, notwithstanding the inferiority of their instruments, by Cassini and Fatio nearly 200 years previously. The dusky markings on the ball appear in the rough designs of the elder Herschel, who also noted, for about a week in 1780, a division, possibly not since seen, near the inner edge of one ansa only of the broad ring. The curious striations of the outer ring shown, among others, by the beautiful object-glass at Nice, date back to the 6½-inch reflector of Kater in 1825, if not to an earlier instrument of Short's; while their existence is now unaccountably ignored by the gigantic achromatics of Chicago, Princetown, and Washington; and other details might be specified, described in earlier days, but not corroborated or referred to now. This is certainly not what might have been expected; nor is it easy to assign its cause. Instrumental imperfection cannot be alleged: some minute dark markings might possibly be obliterated in telescopes which give large spurious disks; but this idea is incompatible with the separation of extremely close stars which the modern instruments effect. Irradiation cannot be supposed to affect perceptibly light of so little intensity as that of Saturn. As far as atmosphere is concerned, we in England might claim many an excuse for failure; yet Dawes and De la Rue and others would point to results unsurpassed elsewhere, and with no more efficient instrument than a 9⅓-inch mirror by With I have repeatedly seen Encke's division, while it is imperceptible with far superior means in the purer American sky. "Personal equation" might be credited with a share in the discrepancies—as, for instance, when on one occasion I missed Enceladus but caught Encke's hair-line at the very time when the reverse was affirmed by the well-trained eye of a friend; but this would be far from covering the whole amount of difference. It remains, therefore, to be seen whether any further advance can be made by sharper, or more widely diffused, or more persistent scrutiny. We wait for further intelligence. We have not heard how far the most remarkable investigations of Bond and his associates at Harvard have been substantiated by the same instrument in the hands of their successors. Something might be looked for at Greenwich from the ready comparison of the workmanship of Merz and Lassell. Few tidings have reached us from the acute research of Schiaparelli; no results from the splendid Roman sky. A greater mass of evidence might be brought to bear upon debateable points, and, in the present state of science, may reasonably be expected.

But even in an improved position as to information we might find a difficulty in interpreting discordant evidence, and deducing from it a consistent conclusion. At present we may incline to the idea that we must take refuge in an actual change of dimensions, or position, or brightness in some of the details. But, even if this would explain more than it will do, we are at a loss as to the possible cause of such changes.

The great difficulty which confronts us is our entire ignorance of the real nature of our object. A certain degree of previous acquaintance with what is before us may in some cases tend to preoccupy the judgment, but in others it assists in clearing the way. We are seldom puzzled in interpreting the aspect of the moon, because we are persuaded of its general solidity and fixity. But what is it that we gaze upon in Saturn? Analogy, often so valuable an assistant, breaks down here. A magnificent globe is set before us, but how little can we guess its constitution! One step would be gained if its density at all resembled our own; but there we are thrown out at once. We simply cannot imagine a state of things so utterly unlike our own experience, or draw any reliable conclusions from what we see. We may safely infer that the surface of the globe is chiefly shrouded in vapour in which currents ascend or descend according to their temperature, and are swept by different times of rotation into longitudinal streaks. And we may further suppose that the atmosphere is of no great comparative depth from the occasional presence of less uniform variations in form and shading, such as would not be compatible with any great difference of velocity between the highest and lowest strata. But as to what may lie beneath, not a conjecture is available; nor do we know that it is ever exposed to the eye. We may assume that the globe is warmer than surrounding space or such alternating currents would not be generated. And, further, since we are favoured with such a view of the polar regions as we can never obtain on Jupiter, we may conjecture that the internal heat is not great, or it would tend, by equalising the temperature of the whole globe, to remove that difference of tint which has been often remarked between the polar and more temperate zones. But these are but guesses, and as such they must remain.

Then, as to the complex ring. Its constitution may be deduced, within certain limits, from theoretical considerations; but it is beyond the power of observation to confirm it. Especially as to the aspect of the dusky veil, if we accept the varied tints that have been ascribed to it in opposite ansæ, it can hardly be said to correspond with the idea of a thinly scattered stream of separate luminous masses, and is still less capable—some would say incapable—of such an explanation where it is projected upon the ball. The brighter ring gives no indication of its structure, while showing from time to time marked variations in the relative light of its parts; and of the period of its rotation—*pace* Sir W. Herschel—there is no evidence at all. Some observers have thought the great division dusky, rather than black as it shows itself to others, and the whole system of markings is stated to be occasionally

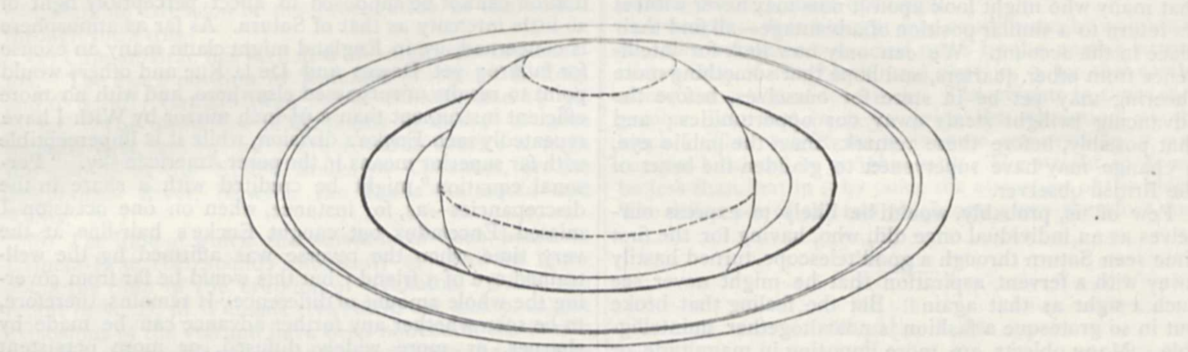


Fig. 1.

unsymmetrical on the opposite sides of the planet—a very perplexing anomaly; for the only conceivable cause—a perturbing influence of the satellites—must be too feeble to have any perceptible effect, even were they not all drawing in different directions.

This claims to be nothing more than a hasty and incomplete notice of a subject of admitted difficulty. Questions like these might easily be multiplied, especially if we took into account such as arise at the time of the edgewise presentation of the ring, its irregularity of illumination, the probable want of parallelism between the axis of the ring-system and that of the globe, the alleged "square-shouldered" outline, and similar peculiarities. Nor has allusion been made to spectroscopic examination, which is stated to have detected the presence of atmospheric bands and those of aqueous vapour, and may possibly, as in the case of the sun, lead to results beyond the bounds of telescopic research. If what has now been said may serve to stimulate further and closer and more systematic inquiry into this wonderful exhibition of creative power, its purpose will have been attained.

T. W. Webb

P.S.—May I be allowed to add that since the fore going paper has been in the printer's hands, the kindness

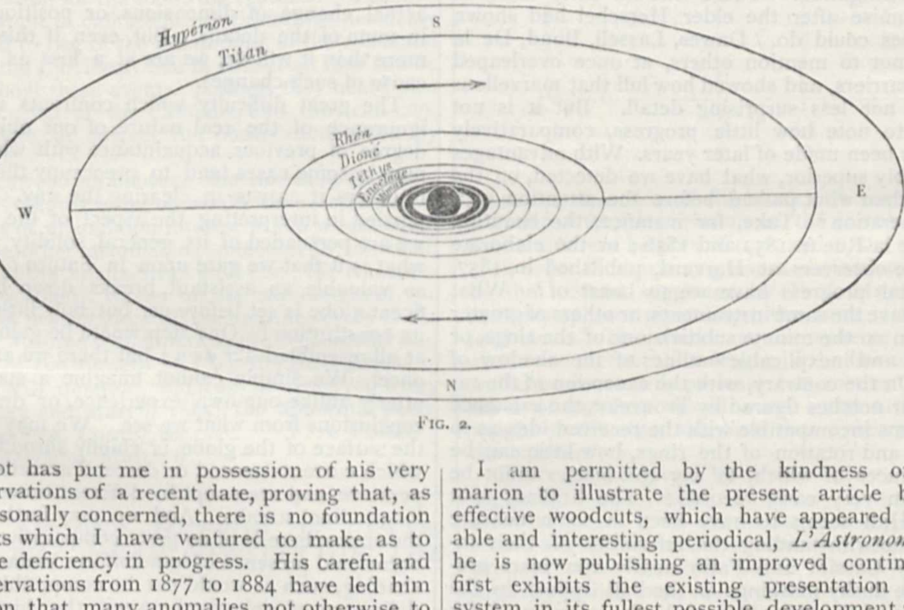


Fig. 2.

of M. Trouvelot has put me in possession of his very important observations of a recent date, proving that, as far as he is personally concerned, there is no foundation for the remarks which I have ventured to make as to our comparative deficiency in progress. His careful and multiplied observations from 1877 to 1884 have led him to the conclusion that many anomalies, not otherwise to be accounted for, must be due to actual variations in the physical structure of the system. It would be a great satisfaction to find that other observatories are likely to prove as fruitful in valuable results as that of Meudon.

I am permitted by the kindness of M. Flammarion to illustrate the present article by two very effective woodcuts, which have appeared in his valuable and interesting periodical, *L'Astronomie*, of which he is now publishing an improved continuation. The first exhibits the existing presentation of the ring system in its fullest possible development; the second, the corresponding projection of the paths of the satellites, in which, however, on account of its great extent, the orbit of the outermost, Japetus, is unavoidably omitted.

T. W. W.

ON PETALODY OF THE OVULES AND OTHER CHANGES IN A DOUBLE-FLOWERED FORM OF "DIANELLA CÆRULEA"

A SPECIMEN, kindly forwarded me by Baron Sir Ferd. von Mueller, of a double-flowered *Dianella cærulea*, has several points of interest. It is an addition to the scanty list of double-flowered plants from the southern hemisphere; it is of interest as having suggested to Robert Brown the establishment of a new species, as was kindly indicated to me by Mr. Baker, while the structural peculiarities it presents are specially worthy of note. With regard to the first point, subsequent experience has shown that the late Dr. Seemann's assertion that there was not "a single double-flowered species known from the southern hemisphere," except *Rubus rosifolius*, no longer holds good, and, indeed, the number of specimens that have from time to time been forwarded to me by Sir Ferdinand von Mueller from various parts of Australia, leads me to believe that such variations are as common in wild Australian plants as in wild European ones, and that, if there be any defect in this particular, it is more apparent than real, and arises partly from insufficient observations, and partly from the relatively smaller number of cultivated plants in Australia. One such instance, that of *Tetratheca ciliata*, presented such features of interest that I made it the subject of a note in your columns, December 7, 1882.

Robert Brown's *Dianella congesta* (*R. Br. Prod.*, 280) is described by Mr. Baker in his systematic summary of the Asparagaceæ (*Journ. Linn. Soc.*, xiv., 1874, p. 576) as having the flowers arranged in dense tufts, in which it differs widely from all the other species of the genus. Mr. Baker expressly says that he had only seen immature flowers. In the "Flora Australiensis," vol. vii., 1878, p. 16, Mr. Bentham alludes to the plant in the following terms:—"*Dianella congesta* . . . appears to me to be a form of *D. cærulea* with dense sessile cymes; the inflorescence, however, in the specimen preserved is scarcely developed, and almost destroyed by insects." The examples sent by Sir Ferdinand von Mueller are, fortunately, in better condition, although, being dried and pressed, they afford little or no opportunity of examining the early stages of development.

Dianella cærulea, as grown in greenhouses in this country, is an elegant perennial plant with grass-like foliage and loose, much-branched cymes of bright blue flowers. Each flower is about half an inch in diameter, and consists of a coloured perianth of six oblong, obtuse segments in two rows; each of the outer segments has five prominent convergent ribs, the inner ones have three only. Within the perianth is a row of six stamens, three of which are placed before the three outer, and three before the three inner perianth-segments, from the base of which they are, indeed, not entirely free. These stamens are remarkable for their thick, club-shaped, fleshy filaments, which support a two-lobed anther opening at the top of each lobe by a terminal pore. The ovary consists of three carpels alternating with the inner row of stamens, and are thus opposite to the sepals, and consolidated into a three-locular ovary with axile placentation, and with numerous ovules in each loculus, the horizontally-disposed ovules being arranged in two longitudinal lines. The ovary ripens into a fleshy ovoid or oblong berry of a lovely blue colour, and containing a relatively small number of seeds as compared to the number of ovules. Indeed, according to the published figures there is much variation in the number of the ripe seeds, abortion of a large proportion being apparently the rule.

So much relating to the usual conformation of the flower is necessary for the comprehension of the changes met with in the malformed specimens. The first thing that strikes attention in them is the substitution of masses of flowers densely crowded into glomerules in place of the light loosely branching panicled cyme met with under normal circumstances. These glomerules look like little "Brussels sprouts," but their constituent parts are somewhat fleshy, and rich cobalt blue in colour. It was this crowded condition of the flowers that doubtless suggested the name "congesta," applied to this form by Brown. On examination of the individual flowers, many changes are observable, and scarcely two flowers present exactly the same characteristics. In most cases a multiplication of the perianth-segments has taken place at the expense of the stamens and carpels, but few or no intermediate forms are met with between petals and stamens, or petals and carpels, neirher are there any indications of staminody of the carpels or the converse. Very frequently the thalamus, or axis of the flower, after having given off several alternating whorls of segments, divides into three or more divisions, each of which, in its turn, gives off successive whorls of densely imbricating blue segments.

The most interesting changes, however, are to be sought in flowers which have not undergone such a serious amount of perturbation as those above-described, and of these a few may be found here and there wedged in among their more full-blown companions. Unfortunately the flowers are so densely packed, and the state of the specimen such, that nothing can be learnt as to the relative position on the inflorescence of these less distorted flowers. The perianth in these cases is normal, but the stamens present some significant changes. The thickened fleshy filament is replaced more or less completely by a slender ribbon-like stalk, not, as in the natural state, continuous with the base of the anther (basifixed), but attached to the back of the anther, a little above its base (dorsi-fixed). This would seem to be an indication that the thickened portion of the filament in the ordinary flower is really an anther-lobe in a state of arrested development.

It will be remembered that Clos and also Goebel are of opinion that the anther is a distinct organ, without direct relation to the lamina of the leaf, and the first-named author considers the filament and its continuation the connective, to be the representative of the median nerve of the petal (Clos: "la feuille florale et le filet staminal"). It would occupy too much space to enter into a discussion on this point: suffice it to add that, in addition to the other changes noted, the anthers in these flowers open by longitudinal slits at the sides, and not by pores. The ovary presented different conditions in different flowers. In almost every case it was preternaturally enlarged, in some instances it was converted from a trilocular to a unilocular condition, owing to the edges of the carpels remaining "valvate," and not inflected, the placentation, of course, in such cases, being parietal, not axile. In other flowers the ovary was represented by three separate, but closed carpels, a retention of juvenile or primordial character, and which, probably, may also be taken as an indication of the condition of the carpels in the progenitors of the Liliaceæ.

But these changes in the carpels are of less interest (owing to the greater frequency of like mutations in other flowers) than are the appearances presented by the placenta and by the ovules, changes unlike anything that has been observed in Monocotyledons, so far as I am aware. These changes in the placenta in the case of the closed unilocular carpels consisted in the outgrowth from the ventral suture of two narrow, parallel, longitudinal plates of a bright blue colour, extending the whole length of the carpels. In flowers in which this petalodic condition of the placenta was present there were no ovules. Are these petal-like processes to be considered as outgrowths from the ventral suture—*i.e.* of foliar origin—or are they to be regarded as springing from the thalamus (axial), and congenitally adherent to the edges of the carpel? Unfortunately there is no means of obtaining a definite reply to this question. They look as if they were outgrowths from the margins of the carpellary leaf, and I should probably have considered them to be so were it not for certain appearances in the ovules to which I proceed now to allude. In the free carpels, in the flowers I examined, no ovules were apparent, but only the petaloid plates just described; but in those cases where the carpels were combined into a trilocular ovary, the ovules were present on each side of the ventral suture, not indeed in a perfect condition, but in a more or less abortive state, consisting merely of a funicle and an irregular plate of cellular tissue more or less blue in colour, the only representative of the coats of the ovule, while the nucellus, so far as I could see, was entirely wanting. Still, the general appearance was that of imperfectly developed, pendulous, anatropal ovules.

Petalody, and especially phyllody, of the ovules is not a very uncommon phenomenon among Dicotyledons, and their peculiarities have been discussed at length in numerous classical treatises, to which it is not necessary here to refer. The corresponding changes in the ovules of Monocotyledons must be very much less frequent. There are none recorded in my "Vegetable Teratology," in which I endeavoured to render the bibliographical notices as complete as possible up to the time of publication, and there are none that I have hitherto been able to find in any subsequently issued publication. It is quite certain then that ovular changes must be of extremely rare occurrence in Monocotyledons. Another point remains to be mentioned—the ovules or their abortive representatives were decidedly pendulous from the ventral suture, but in the same carpel it often happened that two flat, tongue-shaped, petaloid processes projected one on each side vertically upwards from the base of the ventral suture, but quite free from it above their point of origin. These may be the representatives of ovules in spite of their different direction, for a different position of the ovules in the same carpel is by no means an uncommon circumstance, though I am not aware that it has ever been observed in *Dianella*. Naturally one is disposed to connect them with the petaloid plates projecting from the placenta above described; but unfortunately I was unable to find any intermediate condition between the petal-like plates attached to the placenta for its whole length and those which arose from the base of the carpel free throughout their entire length. It is to be hoped that this variety may have been introduced into our conservatories, where, independently of the opportunity for more complete investigation that would thus be afforded, it would be welcomed for the brilliancy of its masses of flowers.

MAXWELL T. MASTERS

MUSICAL SCALES OF VARIOUS NATIONS[1]

AT the Society of Arts yesterday, Sir F. Abel, C.B., F.R.S., Chairman of the Council, in the chair, Mr. Alexander J. Ellis, F.R.S., read a paper on "The Musical Scales of Various Nations," illustrated by playing the scales on his Dichord (a double Monochord, corrected so as to give the true intervals) and five English concertinas, specially tuned by Messrs. Lachenal, which also enabled him to play strains in some of the scales, and by various native instruments lent for the purpose by Rajah Ram Pal Singh, Mr. A. J. Hipkins, and Mons. V. Mahillon. The nations represented were chiefly those of ancient Greece, Arabia, India, Java, China, and Japan, with rapid glances at subordinate places. The relation to his former paper on the History of Musical Pitch was this, that whereas that paper gave the variations in the pitch of the European tuning note, the present endeavoured to discover the system by which different nations tuned. This was obtained when possible by theory, taking as authorities Prof. Helmholtz for ancient Greece; Prof. J. P. N. Land, of Leyden, for Arabia and Persia, and Rajah Sourindro Mohun Tagore for India. When theory was not possible, results were obtained by measuring with his series of 100 tuning-forks the pitch of the notes produced by instruments of fixed tones (as the wood and metal bar harmonicons in Java and elsewhere), or those produced by native players on other instruments (as by Rajah Ram Pal Singh for India, the musicians of the Chinese Court of the Health Exhibition, and of the Japanese village). In obtaining these pitches Mr. Ellis was materially aided by the delicate ear of Mr. A. J. Hipkins, who most kindly cooperated with him in every way. From the pitches thus obtained, the intervals were expressed in hundredths of an equal Semitone (for brevity called cents) of which 1200 make an Octave, 702 a perfect Fifth, 498 a perfect Fourth, 386 and 316 perfect major and minor Thirds. Then these were plotted down on the movable fingerboards of the Dichord, and the scales were made audible. Occasionally forks were constructed of the pitch observed, and from them concertinas were constructed, and thus the most unusual intervals were reproduced to the ear, and their exact relation to those on a well-tuned piano rendered sensible to the eye. After rapidly exhibiting the ancient and later Greek scales, Mr. Ellis turned to Arabia, for which Prof. Land had furnished the data in his *Gamme Arabe* read before the Oriental Congress at Leyden. This showed first the Pythagorean scale, and then its modification by the lutist Zalzal, 1000 years ago, whereby a fret was introduced between those for E flat, 294 cents, and E, 408 cents (supposing the open string to be C), producing the neutral Third of 355 cents, so that the scale became C 0, D 204, E neutral 355, F 498 cents, followed by the same a Fourth higher, and by a whole tone. This was the system prevalent at the time of the Crusaders, who seem to have brought it to Europe in the shape of the bagpipe, and it is still preserved on good highland bagpipes (as those of Glen and Macdonald) as was proved by taking the scale of one kindly played by Mr. C. Keene, the artist. After the time of the Crusades, Arab theorists, scandalised at giving up the series of Fourths to produce the neutral Thirds and Sixths, carried on the system of Fourths to 17 notes, using 384 and 882 cents for Zalzal's 355 and 853 cents, but preserving his name. So came about the mediæval Arabic system of 17 notes to the Octave, from which 12 scales were constructed, of which Mr. Ellis was able to play 10 on one of his concertinas. But Zalzal's system did not die out, and in 1849 Eli Smith, an American Missionary at Damascus, translated a treatise by Mesháqah, a learned contemporary musician, showing that it led to the division of the Octave into 24 Quarter-tones, with the normal scale of 0, 200, 350, 500, 700, 850, 1000, and 1200 cents, while the player was allowed, in certain cases, to increase or diminish the interval by 50 cents, or a Quarter-tone. Eli Smith gives 95 Arabic airs in this system, of which a few were played on a special concertina. The two important points of Arabic music were the introduction of the neutral Third and Sixth, and the variation of normal notes by a Quarter-tone, both thoroughly inharmonic.

In India the ancient scale was the same as our just major scale, with the exception of the Sixth, which was a comma sharper. Hence it had C 0, D 204, E 386, F 498, G 702, A 906, B 1088, C 1200 cents. But then the major Tones were considered to be divided into 4 degrees, the minor Tones into 3, and the Semitone into 2 degrees, and tones were depressed by 1, 2, or 3, and in one case F, raised by 2 or 3 degrees, and thus the 12 changing notes were produced, answering to our 5 chromatic notes, with 7 notes altered by a degree from them, equivalent to the similar process in the Arabic scale. In modern times the scale was simplified by dividing the distance C to F on the finger-board into 9 equal parts, and from F to *c* (the Octave) into 13 equal parts, and then dividing the 22 degrees among the notes thus: (where the figure before the note indicates the number of

[1] Contributed by the Author.

degrees, and the figures after it the number of cents in the interval from the lowest note, while the terms "very" flat and sharp are those used by Rajah S. M. Tagore, President of the Bengal Academy of Music):—1 C 0, 2 D very flat 49, 3 D flat 99, 4 not used, 5 D 204, 6 E very flat 259, 7 E flat 316, 8 E 374, 9 E sharp 435, 10 F 498, 11 not used, 12 F sharp 589, 13 F very sharp 637, 14 G 685, 15 A very flat 736, 16 A flat 737, 17 not used, 18 A 896, 19 B very flat 952, 20 B flat 1011, 21 B 1070, 22 B sharp 1135, and then followed the Octave of the first degree. Mr. Ellis then showed that 4 scales played to him by Rajah Ram Pal Singh corresponded with some of the 32 scales of 7 notes formed by selections from the above 19 (3 of the 22 degrees not being used). There are also 112 scales of 6 notes, and 160 of 5 notes, or 304 scales in all enumerated by Rajah S. M. Tagore. In addition to this the peculiarities of the 6 modes (*rágas*) and their numerous "wives" or modelets (*ráginís*) had to be taken into consideration.

This Indian system, based on stringed instruments, is, however, quite different from that (if any) of the uncultivated tribes. For instance, a wood harmonicon from Patna gave the scale 0, 187, 356, 526, 673, 856, 985, 1222 cents, where the intervals of the Fourth, Fifth, and Octave were mistuned; but the neutral Third and Sixth, 356 and 856, were introduced.

After dealing with some more instruments of the same kind from Singapore, Burmah, Siam, and West Africa, Mr. Ellis proceeded to the scales which are mainly pentatonic, the most perfect of which are those of Java, which he had acquired from the band at the Aquarium in 1882, checked by the observations of Prof. Land and others on similar instruments in Holland. These scales are of two totally different kinds, called Salendro and Pelog. The ideal of the first seems to be the division of the Octave into five equal parts, giving the scale 0, 240, 480, 720, 960, 1200 cents., so that there is a flat Fourth, sharp Fifth, and almost perfect natural Seventh (960 for 969 cents). By playing pentatonic Scotch airs on a concertina thus tuned, Mr. Ellis showed that the scale gave perfectly recognisable results, and he then played some Javese airs reported by Raffles. In this scale no interval between successive notes was so small as a whole Tone, or so large as a minor Third, but approached a neutral 250 cents, which is constantly accepted as one or the other almost indifferently.

The second or Pelog scales have also five notes, but they are selected from a fund of 7, which (being numbered I. to VII.) have the following intervals from the lowest in cents:—I 0, II 137, III 446, IV 575, V 687, VI 820, VII 1098, I 1200. From these the annexed scales were formed:—

Pelog	0,	446,	575,	687,	1098,	1200 cents.
Dangsoe	0,	137,	687,	820,	1098,	1200 ,,
Bem	0,	137,	575,	687,	1098,	1200 ,,
Barang	0,	137,	575,	687,	820,	1200 ,,
Miring...	0,	446,	575,	820,	1098,	1200 ,,
Menjoera	0,	137,	446,	575,	1098,	1200 ,,

These numbers represent the intervals as determined from the pitches actually observed, and it is very improbable that they properly represent the ideal of the intervals. but they were actually used, and hence satisfied Javese ears. It is noticeable, in contradistinction to the Salendro scales, that the Fourth is sharp and the Fifth flat, that there are five intervals approximating to a Semitone (one being exactly a diatonic and another an equal Semitone), and that two intervals are nearly a minor Third, while the Tone proper does not occur. In the individual scales intervals between adjoining notes occur of over a Fourth, or at least a major Third. These two descriptions of pentatonic scales, therefore, quite refute the usual theories, and show that other feelings than those of successions of Fourths and Fifths must have been at work. Mr. Ellis played short strains (not native) to show the effect of these scales on airs.

The presence of Chinese musicians at the Health Exhibition enabled Mr. Ellis, with the aid of Mr. Hipkins, and the cooperation of the Commissioners of the Chinese Court, to take down the pitches of the notes played by natives on (1) the *Ti-tsu*, or transverse flute; (2) the *So-na*, or oboe; (3) the *Sheng*, or mouth organ; (4) the *Yün-lo*, or set of 10 small gongs on a frame; (5) the *Yang-chin*, or dulcimer; (6) the *Tien-tsu*, or tamboura; (7) the *P'ip'a*, or balloon guitar. These scales were very diverse. Probably by different blowing and half covering the holes, 1 and 2 were much altered and could play together, but the scales noted were incompatible. Nos. 1, 2, 3, 4, 5 had all scales of 7 notes, though it was more usual to leave out two notes and play only 5. On 6 and 7 pentatonic scales only were played to them. Nos. 5 and 6 were tuned in their presence. No. 5 was supposed to follow what is given as the scale in Williams's Middle Kingdom, but must have been badly tuned. The following gives the transcription of the Chinese names followed by the cents in the interval from the lowest note; the notes marked * were omitted when only five notes were used:—*Ho* 0, *sz'* 169, **t* 274, *chang* 491, *ché* 661, *kung* 878, **fan* 996, *liu* 1200, which may possibly represent the scale of B flat major, begun on its second note, thus C 0, D 182, *E flat 294, F 498, G 680, A 884, *B flat 996, C 1200. Also the scale played on No. 6, if begun on its Fifth, seemed to be the same. This is the only instance Mr. Ellis met with where two scales were approximately the same. No. 6 has no frets, and hence any intervals were practicable upon it. None of the instruments used equal temperament.

The principal scales of Japan are pentatonic, but they have a means of sharpening notes on the *Koto* by pressure on the strings, thus producing more notes. The "classical" music came from China. The "popular" seems to be indigenous. In this case, in the *hiradio-shi* tuning of the *Koto* (the principal national instrument), both Mr. Ellis's authorities (Mr. S. Isawa, Director of the Institute of Music at Tokio, Japan, and a Japanese at present studying physics in Europe) agree that the intention is, given the note of the 1st and 5th strings in unison, to tune the 2nd a Fifth below it, and the 3rd a Fourth below it. As to the 4th they disagree. Mr. Isawa thinks it was tuned a major Third below, the other thinks his countrymen do not know a major Third, but only tune the 4th string by "a sort of instinct" as "a sort of" Semitone above the 3rd, in which case the interval between the 3rd and 4th will also be "a sort of" major Third, and the Fourth, from the 3rd to the 5th string, will be approximatively divided into a Semitone and a major Third, which is, singularly enough, the oldest Greek tetrachord of Olympos, possibly tuned by a similar "instinct." Then the Fourth, from the 5th to the 7th string, would be similarly divided by the 6th string. Hence, taking the 1st and 5th strings as E, we have 1 E, 2 A, 3 B, 4 C, 5 E, 6 F, 7 *a*, approximatively. Mr. Buhicrosan, of the "Japanese Village," Knightsbridge, kindly allowed Mr. Hipkins and Mr. Ellis to take the method of tuning *hiradio-shi* from one of his female musicians and her music-master. Writing the number of cents in the intervals between the strings, the following was the result:—

Theory ...	II 204	III 112	IV 386	V 112	VI 386	VII
Female ...	193	164	362	82	399	
Master ...	185	152	346	107	410	

The differences seem to bear out the other's views, and are an instructive lesson in the inaccuracies of most Asiatic tuning. Mr. Isawa identifies the intentional Japanese twelve pitch-notes with the twelve notes of our equally tempered scale, and the other says that if Japanese music is played on a piano no Japanese ear will be offended. Practically, however, the scale is more like any badly tuned piano, differing probably from performer to performer, and, as shown by the above comparison, often out by a quarter of a Tone.

Mr. Ellis's conclusion was that there is not anything approaching to a single "natural" music scale. That, on the contrary, the systems, where systems can be said to exist, are very diverse, and often very capricious, and are always very imperfectly carried out. This arises probably from harmony proper being unknown, though *ensemble* playing is common. In the latter case unisons are the rule, the effect being produced by diversity of quality of tone; but certain effects are produced by admitting Octaves, and rarely Fourths and Fifths—no more. Also a kind of polyphony may be remarked, some instruments, especially those with tones of very short duration, being allowed to *discant* while the others go on with the air.

On the whole, Mr. Ellis considers his work has only commenced an investigation which will have to be pursued for many years, principally by physicists with a slight knowledge of music, not by European musicians, whose thoughts are biassed by the system of music in which they are accustomed to think.

NOTES

THE Anniversary Meeting of the Chemical Society will be held on Monday, March 30.

THE Mercers' Company have made a contribution of 52*l*. 10*s*. to the fund on behalf of the family of the late Henry Watts, F.R.S.

WE are glad to see from the recent letter of Sir Spencer Robinson, in the *Times*, that the Admiralty are at last taking to experiment to decide the question as to the best form of war-ship. This is as it should be, and we hope the Admiralty will continue their experiments until they have obtained a solid scientific principle to guide them.

OUR readers may be interested in the following remarkable and well-authenticated instance of the effect of atmospheric influences in varying the distance at which lights are visible at night, communicated to us by a correspondent. The paragraph is taken from the *Aberdeen Journal* of March 21. The steamship referred to was on her weekly voyage from London to Aberdeen, being one of a well-known line of passenger steamers trading within these ports. "*Singular Phenomenon.*—Capt. Marchant, of the s.s. *City of Aberdeen*, reports that owing to the peculiar condition of the atmosphere yesterday morning he saw, quite clear and bright, the Girdleness Light (Aberdeen Bay) at 1 a.m., when his vessel was a little to the south of Montrose, a distance of over thirty-six miles, and when two miles north of Stonehaven he could distinctly see the Buchanness Light (about twenty miles north of Aberdeen and three miles south of Peterhead), at a distance of fully thirty-two miles. The lights are laid down on the Admiralty chart as visible at nineteen and seventeen miles respectively."

THE half-yearly general meeting of the Scottish Meteorological Society was held on March 23. The business before the meeting was:—Report from the Council of the Society; Report of the work of the Scottish Marine Station, by the Scientific Staff of the Station; Anemometrical observations at Dundee, by David Cunningham, C.E., Harbour Chambers, Dundee; Diagram to facilitate hygrometric calculations, by David Cunningham, C.E.; Formation of snow crystals from fog, by R. T. Omond, Superintendent of Ben Nevis Observatory; Meteorology of Ben Nevis, to February 1885, by Alexander Buchan, Secretary.

A TELEGRAM from Fort William reports that the Rev. John M'Kintosh, Free Church minister, and Mr. Colin Livingstone, of Fort William, made the ascent of Ben Nevis on Monday. The weather was fine, but, owing to the quantity of snow on the higher part of the mountain, footing in some parts was obtained with considerable difficulty. This was particularly the case for about 1200 feet above the Red Burn, and crossing steps had frequently to be cut in the frozen snow. The occupants of the observatory at the top of Ben Nevis were found in excellent health and spirits. The buildings, with the exception of the chimneys and tower, are buried in the snow, access to the rooms being obtained through the tower by means of a ladder. But, once reached, the rooms are very comfortable. The junior assistant was found amusing himself with a kind of raft, which was carried over the snow by means of a sail.

AT a special meeting of the Institution of Mechanical Engineers, held on the 20th inst., was read, amongst other papers, one by Mr. R. Heenan on the Tower spherical engine. As its name betokens, it consists of a system of parts contained within a sphere, so united as to enable them under the action of steam pressure to impart rotatory motion to a shaft. Considered kinematically, the three elementary moving parts of which the engine is composed are: a pair of quarter spheres, having a circular disk of the same diameter as the sphere interposed between them. The straight edges of the spherical sectors are hinged on opposite sides of the disks along diameters at right angles to each other. Each sector rotates upon an axis of its own, upon which it is fixed symmetrically; these two axes lie in the same plane, meeting in the centre of the disk at an angle of 135°. The two sectors thus correspond with the two bows of an ordinary universal joint, the disks replacing the crosspiece connecting the bows. Throughout each revolution there are consequently two cavities simultaneously in process of opening and two others in process of closing, all four alike changing at the same mean rate of increase and diminution. If, therefore, the disk with its pair of sectors be encased within a hollow sphere of the same diameter, and, if steam be admitted into the two opening cavities, and exhausted from the two that are closing, continuous rotatory motion will be produced, driving the two shafts represented by the axes of the two sectors. When one of the two opening chambers is only just commencing to open, the other is half open; so that, while the one is making no effort, the other is in the position of best effort. Although the whole of the engine may be said to be contained within the sphere, it is an interesting feature in the system that the capacity of the engine is no other than the full capacity of the sphere itself, inasmuch as four quarters of the sphere are filled and emptied in one revolution. The Tower spherical engines have been used for the electric lighting of trains on the Great Eastern Railway; they have continued running since October 26, 1884, with perfectly satisfactory results. The engine is coupled directly to a dynamo specially made, the two being together on one bed-plate. The whole is mounted on the top of the locomotive-boiler behind the dome, so that it occupies no space on the foot-plate, and the steam can be taken direct from the dome. The construction of the engine was illustrated by means of twenty-six diagrams.

WE have received the Report of the City and Guilds of London Institute for Technical Education for the past year.

M. ALBERT GAUDRY, Professor of Palæontology in the Museum of Natural History, has reproduced as a pamphlet a note read by him before the Academy of Sciences on the new gallery of Palæontology added to the Paris Natural History Museum. This is a provisional gallery for the large skeleton of fossil animals; but M. Gaudry has the vision of a far more perfect and elaborate gallery before his eyes. The new gallery, he says, in concluding his description of its contents, is far from being sufficient. What is needed is a museum where the fossils could be classified, epoch by epoch, and where it would be easy to follow the history of the development of life from the time at which traces of it are perceptible down to the coming of man. "We may hope that one day France, where Cuvier founded the science of fossils, shall have a palæontological museum worthy of her. Meanwhile the new gallery will render a service, for it will give some idea of the majesty of ancient nature."

THE Electrical Exhibition held at the Observatory of Paris was opened by the President of the Republic on the 21st inst. The Ministers of Postal Telegraphy and Public Instruction were present. A Gramme machine was used for rotating the large dome on the roof of the establishment; the rotation of the dome was made visible at a distance by a ray of electric light sent through the aperture. Transmission of force to a distance was shown by setting into operation a printing machine. A series of lectures is being delivered on the several topics relating to electricity in a room fitted up for the purpose. The first is by M. Wolf, on the Application of Electricity to Astronomy, and the last by M. Marié-Davy, on the Use of Electricity in Prognosticating the Weather. All these lectures will be taken down by shorthand writers and published.

THE *Meteorologische Zeitschrift* for February contains a notice by Dr. Eschenhagen on the effect of the Spanish earthquake of Christmas Day last on the magnetic registering apparatus at Wilhelmshaven. During 1883 neither the earthquake of Ischia nor the Krakatoa catastrophe had any influence whatever on the instruments at that place, while an investigation of the curves of the magnetograph during the Andalusian shocks gave the following results. Of the three instruments employed for measuring magnetic variations, only one, that for the vertical intensity, showed any perceptible change at the time of the shock. The curve for horizontal intensity was broken at that point by an unfortunate accident: the declination instrument marked complete rest, but there was a movement of the unifilar suspended magnet such as might be produced by a shock in the direction from south to north. The movement of the needle at the time of the earthquake had not the character of a magnetic disturbance, but was a simple swinging to and fro. The curve showed a gap at this point, for the rapid swinging could not be registered, until the motion became fainter. The first shock to the balance on December 25 was, with tolerable exactitude, 9h. 52m. Wilhelmshaven time, and ceased at 9h. 56m.; new shocks took place at 9h. 59m., 10h., 10h. 2m., and 10h. 5m. Dr. Eschenhagen does not doubt that the balance acted at this time as a kind of seismograph. Accurate observations as to the precise moment of the outbreak of the earthquake at its centre are not forthcoming; but according to the newspapers the first shock was felt at Madrid at 8h. 53m., Madrid time, while the same time is also given for Seville; we may therefore take this to be the time for the Sierra Nevada region, and the shock in Granada, which lay about the centre of the movement, would then be at 9h. 8m. Greenwich time. At Greenwich, however, it was registered at 9h. 15m. in a similar way to that at Wilhelmshaven. It reached the latter place at 9h. 19.4m. Greenwich time. The distance between London and Granada is about 1650 kilometers, but between Wilhelmshaven and Granada 2040 kilometers, and the wave would have taken 7 m. to traverse the former, and 11·4 m. the latter distance. This would give varying degrees of speed in propagation, and if we regard the difference of 390 kilometers as traversed in 4·4 m., we get a third rate of speed which, perhaps, proves that the speed lessens considerably with the distance. It should not be forgotten that Wilhelmshaven is surrounded by marshy ground, which might have retarded the progress of the shock. It appears, too, that the general movement was not propagated in concentric circles.

A WRITER in a recent issue of the *North China Herald* describes a work on "The Mathematicians and Astronomers of China and Foreign Countries," compiled toward the close of the last century by a scholar who afterwards became Viceroy of Canton. It is in ten volumes and forty-six chapters, of which three only are devoted to foreign astronomers and mathematicians. Forty-one of these are mentioned, but a few foreigners are included in the chapters on the natives, for during the 4000 years which the history covers there has always been a leaking-in of knowledge, in spite of the isolation of China; and when foreign mathematicians were to be had, China has made use them. The earliest Chinese astronomers recorded in this history were in the reign of Huang-Ti, and are purely legendary. One invented the cycle of sixty years, another the twelve musical tubes which constitute the basis of weights and measures. These are supposed to have lived in the twenty-seventh century before Christ, but, as they were not heard of until more than 2000 years later, one may assume almost any thing about them except that they lived at the date assigned to them. The first real astronomers whose names remain are the official astronomers of the Emperor Yao. The foundation of scientific astronomy was then laid in the intercalary month and in the use of an instrument for comparing the movements of the stars and the planets with those of the sun and moon. The next scientific triumph mentioned is the measurement of the width of the earth, which is stated to be 2,333,000 *li* 325 feet from east to west, and 2,335,000 *li* 225 feet from north to south. This statement is found in a certain "Shan Hai Ching," a very old but fabulous work. The Chinese take it as a proof that in ancient times latitude and longitude were understood, because it is said that the official measurer calculated with his right hand, and with his left pointed to the north side of a certain hill. An astronomer who lived in the eleventh century before Christ appears to have been in advance of the Greek mathematician, for it is recorded that he explained to his friend, a certain great sage, that the two sides of a right-angled triangle being taken as three and four, the hypotenuse will be five. The statement as given also embraces the squaring of the circle, "the square comes out of the round as earth comes out of heaven." This comes from an ancient work which is said to be the only one stating the principle that a round heaven rests on a flat earth. But the same book states that the earth is round, and that the length of the day and the variation of temperature depend on the latitude. The Emperor Kang Hsi, towards the close of the last century, pointed to the work here referred to as evidence that trigonometry certainly went from China to Western countries in ancient times. During the various dynasties that have ruled in China since our era, the number of astronomers whose labours are recorded have progressively increased, especially after the invention of printing. The forty European astronomers mentioned form a classified list, mainly of ancient Greeks and moderns. Ptolemy, Copernicus, and King Alphonso are placed side by side, and Tycho Brahe is closely followed by Archimedes and Napier. The translators of scientific books from among the Roman Catholic missionaries in China are in close proximity with Newton and Kepler. They won their position in the Chinese estimation amongst the great philosophers by their efforts as translators to teach the Chinese such facts and theories as they knew. The whole work shows that the Chinese honour men of scientific knowledge, and that a number of themselves are always ready to devote themselves with enthusiasm to the study of the mathematical sciences.

THE Royal Academy of Sciences of Belgium has issued a notice with reference to an extraordinary competition for the year 1887. The Government has proposed, and the Chambers have adopted a law having for its object the preservation of fish and their restoration to the rivers. The main obstacle to this end is the pollution of the waters of small unnavigable streams by solid and liquid matter poured into them by various industries, which render them unfit for the breeding and existence of fish. The Academy, therefore, calls on science to aid the public authorities. One of its members has placed at its disposal the sum of three thousand francs, which it has decided to spend in giving a prize for a thorough study of the following questions, at once biological and chemical:—(1) What are the special substances in our principal industries which, when mingled with the water of small streams, render them incompatible with the existence of fish and unfit for the consumption of man and beast? (2) Investigation and indication of practical measures for purifying water as it leaves manufactories, so as to render it innocuous to fish without interfering with the industry, combining the expedients offered by decanting basins, filtering and chemical agents. (3) Separate experiments on the substances which in each special industry kill fish, and on the degree of resistance which each species of edible fish offers to this destruction. (4) A list of the rivers in Belgium which are actually depopulated by this state of things, with an indication of the special industries in these rivers, and a list of the edible fish which inhabited them before the establishment of the factories. If a memoir is judged satisfactory for the solution of the two first points, a prize of two thousand francs will be given, even though the two latter questions are untouched. Papers should be legibly written, and should be addressed to M. Liagre, Perpetual Secretary, au Palais des Académies, Brussells, before October 1, 1887. Quotations are to be made with great exactness, and authors should therefore mention the edition and page of works cited. A motto must be selected, and the names inclosed in a separate sealed envelope, with the motto superscribed. The papers sent in will remain in the archives of the Academy.

A RECENT issue of the *Peking Gazette* contains a report from the outgoing Viceroy of Fukhien stating that he had handed over the insignia of office to his successor, including *inter alia* the seal, the imperial death warrant, banners and tablets, and the conch-shell best used by the Throne. The latter has a curious use. A conch-shell with a whorl turning to the right is supposed when blown to have the effect of stilling the waves (from the excruciating nature of the sound?), and is hence often bestowed by the Emperor upon high officers whose duties compel them to take voyages by sea. The Viceroy of Fukhien probably possesses one of these shells in virtue of his jurisdiction over Formosa, to which periodical visits of inspection are supposed to be paid.

UNDER the title "A Prophetic Almanac a Hundred Years ago," *Science et Nature* describes, with illustrations, portion of one of a series of almanacs issued between 1789 and 1799, which has recently been presented to the Paris Bureau of Meteorology. The collection was made at the time by Guéneau Montbeillard, the colleague of Buffon, and the author of the section on birds in the latter's natural history. Montbeillard was also a meteorologist, and his observations, made at his chateau at Semur in Côte-d'Or, can be employed to check the prophecies made in the *Almanach fidèle* published annually at Troyes, "par les soins du sieur Maribas, grand astrologue et mathématicien." Selecting the page of the almanac for the month of March, 1785 (precisely a century ago), we find in the last column, in ordinary language, general predictions for the four quarters of the month. For example: "New moon on the 10th, at 10h. 38m. in the evening, in the sign Pisces. The weather will be fine, and the winds very troublesome." Next to this come four columns, filled with cabalistic signs and occupying the middle of the page. The last of these gives for each day the position of the moon in one of the zodiacal signs. The first of the four indicates by a cross or a triangle whether the day is a festival or a working day. In the second column the nature of the weather which may be expected is marked by a succession of signs, the key to which is given in the first page, while the third, by a similar series of signs, indicates the nature of the operations for which the day in question is particularly favourable. Thus Sieur Maribas advises his clients that March 10th, 11th, and 28th, 1785, are favourable for hair-cutting; the 12th, 13th, and 27th for paring the nails; the 2nd, 14th, and 21st for blood-letting; but there was only one day, March 4, on which pills should be taken, while it would be unwise to wean infants on any day but the 18th. For wood-cutting, the 9th, 15th, or 16th should have been selected, and so on. The philosopher's weather predictions for the month appear to have been falsified in almost every instance. He foretold rain for seven days and snow for two; in fact it rained very slightly on three days, none of which were mentioned by him, and did not snow on his days at all. In temperature his luck was as bad, for the day which he foretold would be warm, was the coldest of the whole year. Besides, "the various changes of the air for each day produced by the stars on our horizon," Sieur Maribas promises in his title page, "several pretty sayings suitable for exhilarating and diverting curious and melancholic minds." Among these meteorological *gentillesses* are the following:—Women are cured of laziness by vanity or by love; To know a woman well, it is necessary to contradict her; Nothing grows old so soon as a benefit. The "grand astrologer and mathematician" evidently intended his "pretty sayings" chiefly for those of a melancholic turn of mind.

WE have received the *Proceedings* of the Holmesdale Natural History Club for the years 1881, 1882, and 1883. This club has its home at Reigate, and its papers, though mainly concerned with south and central Surrey, range over a great variety of natural history subjects. Among the principal papers in this number (which, it should be remarked, would be much improved by an index, or classified list of the papers) are:—The potato disease, by Mr. Gill; the hairs of plants as concerned in the supply of water and nourishment, by Dr. Bossey; ornithology in Wray Park, by Mr. Crosfield; the *Sprolegna ferox* (the freshwater fish parasite), by Mr. Boyle; the habits of the stalk-eyed crustacea of the British Islands, by Mr. Lovett; and the marine life of the Reigate district, by Mr. Gilbert. All the excellent work of the Club appears to be done with an expenditure of from 30*l.* to 40*l.* per annum.

WE are asked to state that in the report of Sir William Thomson's Baltimore lectures, p. 296, in line 13 from the top of the page, and in the left hand members of equations (19) and (21), for "ω" and "ω_1" read "ϖ" and "ϖ_1" respectively.

THE additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey (*Cercopithecus cynosurus*) from South Africa, presented by Mr. W. E. Clift; a Grivet Monkey (*Cercopithecus griseo-viridis*) from South Africa, presented by Mr. W. Ockey; a Pine Marten (*Mustela martes*) from Ireland, presented by Mr. Frank Sharp; a Bar-breasted Finch (*Munia nisoria*) from Java, two St. Helena Seed-Eaters (*Crithagra butyracea*), a Grey-necked Serin Finch (*Serinus canicollis*), a Brown Canary Finch (*Serinus tottus*), two —— Finches (*Serinus* ——) from South Africa, presented by Mr. J. Abrahams; two Pheasants (*Phasianus colchicus*), British, deposited; a Stein-bok (*Nanotragus tragulus* ♀), four Wattled Starlings (*Dilophus carunculatus* ♂ ♂ ♀ ♀), two White-throated Seed-Eaters (*Crithagra albogularis* ♂ ♀), two Striated Colys (*Colius striatus*) from South Africa, two Brazilian Tanagers (*Ramphocœlus brasilius*), two Green-headed Tanagers (*Calliste tricolor*) from Brazil, purchased

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, MARCH 29 TO APRIL 4

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

At Greenwich on March 29

Sun rises, 5h. 44m.; souths, 12h. 4m. 44·7s.; sets, 18h. 27m.; decl. on meridian, 3° 34′ N.: Sidereal Time at Sunset, 6h. 56m.

Moon (Full on March 30) rises, 17h. 20m.; souths, 23h. 32m.; sets, 5h. 33m.*; decl. on meridian, 0° 35′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 3	13 0	19 57	10 27 N.
Venus	5 37	11 32	17 28	1 31 S.
Mars	5 32	11 30	17 28	1 10 S.
Jupiter	14 12	21 28	4 44*	13 49 N.
Saturn	8 38	16 43	0 48*	21 51 N.

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

Occultations of Stars by the Moon

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
29	75 Leonis	5½	0 14	1 25	75 284
29	76 Leonis	6	1 36	2 17	43 334
29	79 Leonis	5½	3 57	4 54	112 287
31	B.A.C. 4591	6	21 20	22 26	18 240

Phenomena of Jupiter's Satellites

March	h. m.		March	h. m.	
29	1 32	I. ecl. reap.	31	19 14	III. ecl. disap.
	19 44	I. tr. ing.		22 41	III. ecl. reap.
	22 4	I. tr. egr.	April		
30	20 0	I. ecl. reap.	1	19 11	II. occ. disap.
31	0 6	II. tr. ing.		23 53	II. ecl. reap.
	3 1	II. tr. egr.	2	2 59	IV. tr. ing.
	19 13	III. occ. reap.	4	3 5	I. tr. ing.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

March 30.—Partial eclipse of the Moon. The times of first contact with the penumbra and shadow are 13h. 49m. and 14h. 58m. respectively; the middle of the eclipse is at 16h. 34m.; the times of last contact with the shadow and penumbra are 18h. 9m. and 19h. 18m. respectively. The Moon will rise at Greenwich after having left the shadow but whilst still obscured by the penumbra.

GEOGRAPHICAL NOTES

It seems probable that the Geographical Societies of Berlin and Munich will join that of Vienna in sending Dr. Lenz to Africa.

Mr. O'Neill, our Consul at Mozambique, who has done some excellent exploring work in the Lake Nyassa region, has just arrived in this country, and will shortly read a paper before the Royal Geographical Society.

At the meeting of the Geographical Society on Monday, when a paper by Major Holdich was read on the geographical work of the Afghan Frontier Commission, Sir Richard Temple spoke in strong terms of the complete ignorance of geography in this country and the consequent incompetency of the public to judge of the true bearings of such a matter as that now pending between Russia and England. The Society, he remarked, performs a public service in bringing before the public such papers as that of Mr. Holdich, and we hope they will succeed in obtaining for geography the position it ought to have in English education.

We learn from the *Times* Paris Correspondent that the War Ministries of France, Germany, and Italy have recently been examining attentively geographical maps in relief, constructed on a system of which M. de Mendouca, a Portuguese Councillor of State, President of the Banco Lusitano, possesses the patent, and is the promulgator. These relief maps are stated to combine the advantages generally admitted to be possessed by relief maps and the convenience and accuracy of maps on flat surfaces. The Correspondent states that this new method rapidly reproduces, by a chemical and mechanical process, plane maps with the curves and altitudes in relief, so represented as to correspond absolutely with the elevations established by accurate observations. These maps are drawn on paper, which may be described as thin. They are not, however, put out of shape even by being trodden upon. Yet they may be rolled up and placed in the narrowest case, so that they are very portable and light. They are not injured by water. The Correspondent soaked one of them for forty-eight hours in water, and, on taking it out, all the part which was in relief—that is all the part subjected to chemical processes—remained absolutely intact. The relief, the Correspondent states, is produced on them in such a manner that at a single glance one can take in the whole topography of a district, its defiles and heights, its water-courses, and all the lesser obstacles of the country in which military operations have to be carried on. Of course relief maps are well known and plentiful. The drawback to those which include large areas is that the altitudinal scale has to be greatly exaggerated. Both in Germany and Switzerland beautiful reliefs of limited areas are made, not only in plaster, but also in papier-mâché, the horizontal and altitudinal scales of which are the same. These new maps, however, seem to possess many advantages over either plaster or papier-mâché, and we should like to know how large are the areas which are contained in them. We are also curious to learn the chemical process used, and whether embossing is not to some extent employed.

In the *Mittheilungen* of the Vienna Geographical Society for February (Bd. xxviii. No. 2), Prof. Blumentritt describes the states existing in the Philippine Islands at the time of the Spanish Conquest. These were of two kinds: Mohammedan principalities, which were the larger and more important, the polity of which was based on the feudal system; and a vast number of small states, consisting of only a few villages each, in which the Government was based on a complicated system of slavery. The latter is described at considerable length, and is exceedingly interesting. Herr Heller completes his paper on the Rilo-Dagh; while Baron Kaulbars translates from the Russian the recent letters of Col. Prjevalsky from Central Asia. The President, we are glad to observe, was able to announce that the recent appeal of the Council for more members to enable the Society to take a place worthy of the Austrian capital in geographical science has been very successful, 402 new members having joined up to February 24. At the meeting held on that date the Librarian, Dr. Le Monnier, described Mr. Thomson's recent journey into Eastern equatorial Africa; and Dr. Zehden read a paper on Shamanism in Upper Austria, which will be printed in the next part of the *Transactions*.

The last number of the *China Review* contains a lengthy paper on Formosa by Messrs. Colquhoun and Stewart-Lockhart. It professes to be based on all available sources of information, and on the evidence of those who have resided and travelled in the island. The most interesting section is one on the Dutch in Formosa, which is followed by an account of the Chinese rule. The physical geography, and the cities and communications, are treated in some detail; but the portion on the aborigines was written without much reference to "available sources." The precise position of these aborigines is one of the most curious problems in ethnology, and very much more has been written about them than the authors of this paper seem to be aware of. They note a very curious custom among the males. They are deprived of their eye-teeth, which are knocked out when they are quite young. By some it is thought that this improves the wind for hunting, whilst others consider that it increases the beauty of their appearance.

ACCIDENTAL EXPLOSIONS PRODUCED BY NON-EXPLOSIVE LIQUIDS[1]

II.

The disaster on board the *Triumph*, combined with the fact that this xerotine siccative had been issued to H.M.'s ships generally, the authorities and officers of the navy having been in ignorance as to its dangerous nature, re-directed official attention

[1] Address delivered at the Royal Institution of Great Britain, Friday March 13, 1885, by Sir Frederick Abel, C.B., D.C.L., F.R.S., M.R.I. Continued from p. 472.

to the loss of the *Doterel* on April 26, 1881, while at anchor off Sandy Point, by an explosion, or rather by two distinct explosions following each other in very rapid succession, which caused the death of eight officers and 135 men, there being only twelve survivors of the crew. The inquiry by court-martial into the catastrophe had led to the conclusion that the primary cause of the destruction of that vessel was an explosion of gas in the coal-bunkers, caused by disengagement of fire-damp from the coal with which these were in part filled. Its distribution through the air in the bunkers and in air-spaces adjoining the ship's magazine was believed to have taken place to such an extent as to produce a violently explosive mixture, and that this had become accidentally inflamed, causing a destructive explosion, which was followed within half a minute by the much more violent explosion of the ship's magazine, containing four or five tons of powder, to which the flame from the exploding gas-mixture had penetrated.

The circumstances elicited by the inquiry, coupled with the information relating to explosions known to have occurred in coal-laden ships which had been collected by a Royal Commission in 1876 (of which the lecturer was a member), combined to lend a considerable amount of probability to the view adopted by the court-martial in explanation of an accident for which there appeared to be no other reasonable mode of accounting.

The conclusion arrived at led to the appointment of a committee under the presidency of Admiral Luard (of which Prof. Warington Smyth and the lecturer were members) to inquire into the probabilities of coal-gas being evolved, and of an explosive gas-mixture accumulating in consequence in the coal-bunkers of ships of war, and into the possible extent and nature of damage which might be inflicted upon ships of war by explosions due to the ignition of such accumulations. The committee were also instructed, in the event of their finding that H.M.'s ships were liable to exposure to danger from such causes, to consider and devise the means best suited for preventing dangerous accumulations of gas in the coal-bunkers which are distributed over the various parts of the ship in the different classes of vessels composing the Royal Navy.

The committee instituted a very careful inquiry, and a series of experimental investigations, including the firing of explosive gas-mixtures, in large wrought-iron tanks in the first instance, and afterwards in one of the large bunkers, empty of coal, in an old man-of-war, which afforded some comparison with the condition, as regards the relative strength or powers of resistance of the surroundings, and with the position, relatively to the ship's magazine, of the particular bunker in the *Doterel* in which it was thought the explosion might have originated. The results of these experiments could not be said to do more than lend some amount of support to the belief that effects of the nature of those ascribed to the first explosion in the *Doterel* might have been produced by the ignition of a powerfully explosive gas-mixture, contained in the middle- or athwart-ship's bunker of the ship. The committee's experimental investigations for ascertaining the best general method of securing the efficient ventilation of the coal-bunkers in different classes of men-of-war was, however, of considerable advantage in leading to the general adoption of arrangements in H.M.'s ships whereby the possible accumulation in the bunkers of gas which may be liable to be occluded from coal after its introduction into them is effectually prevented, and the occurrence of the kind of accidents guarded against, of which there are several on record, due to the ignition of explosive mixtures which have been produced in coal-bunkers.

Although the inquiry instituted by the court-martial in August, 1881, into the loss of the *Doterel* was apparently very exhaustive, some significant facts connected with the existence of a supply of xerotine siccative in the ship, which appear to have had a direct bearing upon the occurrence of the disaster, only came to light accidentally in January, 1882. A caulker formerly on the *Doterel*, but then employed in the *Indus*, recognised, while some painting was being done in that ship, a peculiar odour (as he called it, "the old smell") which he had noticed in the lower part of the *Doterel* the night before the explosion; on inquiry as to the material which gave rise to it, he learned that it was due to some of the same material, xerotine siccative, that had caused the explosion in the *Triumph*. Upon this being communicated to the authorities, an official inquiry was directed to be held, and it was then elicited that the very offensive smell due to the crude petroleum spirit of which this xerotine siccative mainly consisted, had been observed not only by this man (who in his evidence before the court-martial had not alluded to the circumstance), but also by several others in the *Doterel*, between decks, the night before the explosion; that, on the following day, a search was made for the cause of the odour, and that a jar containing originally about a gallon of the fluid, which was kept in a space at the bottom of the foremast, together with heavy stores of various kinds, was found to have been cracked, the principal portion of its contents having leaked out into the bottom of the ship. The cracked jar was handed up to the lower deck with the siccative still leaking from it, and orders were given to throw it overboard on account of the bad smell which it emitted; this was done within a very few minutes after the jar had been removed, and the first explosion occurred almost directly afterwards. Instructions had been given to clear up the leakage from the jar after the hatch of the mast-hole had been left off a little time, and it appeared that a naked candle had been given to the man who handed the jar up out of the small store-hold described by that name. There appears very little room for doubt that an explosive mixture of the vapour and air had not only been formed in the particular space where the jar was kept, but that it had also extended through the air-spaces at the bottom of the ship towards and underneath the powder-magazine, so that even the air in the latter may have been in an explosive condition, as many hours had elapsed between the time when the smell of the petroleum spirit-vapour was first noticed and when the first explosion occurred.

The special committee which had inquired into the possibility of the occurrence of a violent gas explosion in the coal-bunkers of the *Doterel* was directed to institute experiments with a view of ascertaining whether the vapour evolved by this xerotine siccative would, in the circumstances indicated by the official inquiry, have furnished an explosive gas-mixture possessing sufficient power to have produced the effects resulting from the first explosion on the *Doterel*, and to have exploded the powder-magazine. A preliminary experiment showed that when a small quantity of the liquid was spilled at one extremity of a wooden channel 7 feet long and 2·5 inches by 3 inches in section, the vapour had diffused itself in the space of three minutes throughout the channel to such an extent that, on a light being applied at one end, the flame travelled along very rapidly to the other end, igniting a heap of gunpowder which had been placed there. Some of the liquid was also spilled upon the bottom of a very large sheet-iron tank, and after this had remained closed for about twenty-four hours, being exposed on all sides to the cool air of an autumn night, and therefore not under conditions nearly so favourable to evaporation as those obtaining in the hold of a ship, the application of flame produced an explosion of such violence as to tear open the tank. Experiments were also made with the liquid in an old man-of-war, under conditions somewhat similar to those which existed in the *Doterel*, and destructive effects were obtained of a nature to warrant the conclusion that the first explosion in the *Doterel* might have been due to the ignition of an explosive mixture of the air in the confined space at the bottom of the ship, with spirit vapour furnished by the liquid which had leaked out of the jar.

It is very instructive, as indicating the manner in which volatile liquids of this class may, if their nature be unsuspected, be the causes of grave disasters, to note that, while stringent regulations apply, and are strictly enforced, in our men-of-war in connection with the storage and treatment of explosives and inflammable bodies carried in the ship, the introduction into the service of this highly volatile liquid, and its supply to ships in small quantities, was speedily followed by two most calamitous accidents because the material was only known under the disguise of a name affording no indication of its character. Its dangerous nature had consequently escaped detection by the officials through whose hands it had passed, the makers of the preparation having, in a reprehensible manner which cannot but be stigmatised as criminal, withheld the information which most probably would have, at the outset, acted as a prohibition to the adoption of this material by the Admiralty for use in ships, or which would, at any rate, have led to the adoption of very special precautions in dealing with this material.

Although not initiated, nor attended, by any explosion, the accident which in December, 1875, caused the loss, by fire, of the training-ship *Goliath* off Grays (near Gravesend) and the death of several of the boys by drowning, claims notice as an illustration of the facility with which, by heedlessness, or inattention to obvious precautions, accidents may be brought about in the use as an illuminating agent of mineral oil or petroleum, even where these are of such low volatility, or high "flashing point," as to entitle them to be considered as safe, under all ordinary conditions, as vegetable or animal oils. The evidence elicited at the coroner's inquest showed that one of the boys of the *Goliath*, whose duty it was, at the time, to trim the lamps used in the ship, to place them in position and remove and extinguish them in the morning, and to whom this work had been but recently allotted, let fall a lamp which, after having lowered the flame, he had carried from its assigned position into the lamp- or trimming-room, and which he could hold no longer on account of its heated state. The heated oil was scattered upon the floor, and was apparently at once inflamed by the burning wick of the lamp; the floor of the room was, it appears, much impregnated with oil which had been let drop from time to time by lads employed upon the work of lamp-trimming; hence the flame attacked the apartment generally with considerable rapidity, and a wind blowing at the time caused the fire to spread through the vessel so very quickly as to compel many of those composing the crew to jump overboard, and to render the rescue of the boys from burning or drowning a difficult matter. The occurrence of this accident was made the occasion, in some of the public papers, to decry petroleum oil as a dangerous illuminating agent, although it was proved that the particular oil used at the time when the fire occurred had so unusually high a flashing-point that the consequent inferiority of its burning quality had been made the subject of complaint. This low volatility of the oil has been occasionally regarded as one very important element of safety in reference to its employment in lamps, but the lecturer will presently have to refer to circumstances which do not substantiate this view. At any rate, however, although the heated oil which was spilled on to the floor from the lamp was in a condition favourable to immediate ignition by the burning wick, it is not at all likely that the fire would have extended almost at once with uncontrollable violence, especially in face of the excellent discipline and arrangements in case of fire which were shown to have existed in the *Goliath*, if the scrupulous cleanliness and care had been enforced which were essential in a room where lamp-filling and trimming were regularly carried out, and where it was necessary to keep some supply of oil for current consumption. Instead of this, the floor, and probably therefore other parts of the room, appear to have been in a condition most favourable to the rapid propagation of the flame; moreover, the evidence as to proper care having been taken to keep the supply of oil required for current use in such a way as to guard against its being accidentally spilled, or to impress the boys employed upon the work with the great importance of care and cleanliness, was by no means satisfactory, and there can be little doubt that this catastrophe has to be classed among the numerous accidents of a readily avertible kind which have contributed to lead the public to form an exaggerated estimate of the dangerous character of petroleum oil as an illuminant.

The employment of liquid hydrocarbons as competitors with animal and vegetable oils in lamps for domestic use is of comparatively recent origin, although petroleum or mineral naphtha in its crude or native conditions was used at a very early date in Persia and in Japan, in lamps of primitive construction, while in Italy it was similarly employed about a century ago.

The application of the most volatile products of coal distillation to illuminating purposes in a crude way appears to have originated, so far as Great Britain is concerned, with the working of a patent taken out by Lord Dundonald in 1781, for the distillation of coal, not with a view to producing gas, but for the production of naphtha, brown or heavy oil, and tar.

In 1820, at about the time when gas-lighting was being established in London, his successors sold coal-naphtha in the metropolis for illuminating purposes; but the first really successful introduction of naphtha as an illuminating agent was made by Mr. Astley shortly afterwards, through the agency of the so-called Founders' blast-lamp, which came into use for workshops and yards in factories, and of the naphtha lamp of Read Holliday, of Huddersfield, with which we are well acquainted to this day, as, although it never became a success for internal illumination of houses, it still continues in extensive use almost in its original form, by itinerant salesmen and showmen.

In the Founders' lamp a current of air, artificially established, was made to impinge upon the flame and thus to greatly assist the combustion of the crude heavy oil used in it.

In the Holliday naphtha lamp the spirit finds its way slowly rom the reservoir through a capillary tube to a small chamber placed at a lower level, which has a number of circumferential perforations, and is in fact at the same time the burner of the lamp and the vapour producer which furnishes the continuous supply of illuminant, the liquid supplied to the chamber being vaporised by the heat of the jets of flame which are fed by its production.

Between 1830 and 1850 the knowledge of the production not only of oils but also of paraffin by the distillation of coal or shale became considerably developed by Reichenbach, Christison, Mitscherlich, Kane, du Boisson, and others, and the practical success attained by the latter was soon eclipsed by that of Mr. James Young, who, after establishing oil distillation at Alfreton from the Derbyshire petroleum, began to distil oils from the Bathgate mineral in 1850, and soon developed this industry to a remarkable extent.

The first lamps for burning liquid hydrocarbon which competed for domestic use, in this country, with the superior kinds of lamps, introduced after 1835, in which animal or vegetable oils were burned (solar lamps and moderator lamps), were the so-called camphine lamps (known as the Vesta and Paragon lamps) in which carefully rectified oil of turpentine was used. They gave a brilliant light, but soon acquired an evil reputation as being dangerous, and liable, upon the least provocation, especially if exposed to slight draughts, to fill the air with adhesive soot-flakes.

After a time Messrs. George Miller and Co., of Glasgow (who held for a time the concession of the products manufactured by Mr. Young) tried with some amount of success to use the lighter products from the boghead mineral in the camphine lamp, but the chief aim of Mr. Young appears to have been to produce the heavier oil suitable for lubricating purposes, the light oil or naphtha meeting with an indifferent demand as a solvent, in competition with coal-tar naphtha, in the manufacture of india-rubber goods. He, however, himself used the mineral oil produced at Alfreton in Argand lamps in the earliest days of his operations; a small sale of the Bathgate oil took place about 1852–53 for use in Argand lamps, and the earliest description of lamp employed in Germany, where the utilisation of mineral oil as a domestic illuminant was first developed, appears to have been of the Argand type.

In 1853 a demand sprang up for the lighter paraffin oils in Germany. For three or four years previously a burning oil was distilled from schist or brown coal at Hamburg by a Frenchman named Noblée, who gave it the name of *photogene*. The existence in Glasgow of a considerable supply of the oils became known to a German agent, and after they had been exported from Glasgow to Hamburg for a considerable time it was found that the chief purchaser was Mr. C. H. Stobwasser, of Berlin, who appears to have originated the really successful employment of mineral oils in lamps for domestic use, and to have been the first to bring out the flat-wick burners for these oils. After a time Messrs. Young discovered the destination of their oil, and, having brought over a number of German lamps, for which a ready sale was found, commenced the lamp manufacture upon a large scale, and rapidly developed the trade in mineral (or paraffin) oil for burning purposes, which attained to great importance some time before the American petroleum oils entered the market. In 1859 a firm in Edinburgh supplied Young's company with nearly a quarter of a million of burners for lamps, and it was not until 1859 that the foundation of the United States' petroleum history was laid by Col. G. L. Drake, who first struck oil (in Pennsylvania) at a depth of 71 feet, obtaining at once a supply of 1000 gallons per day. The lamps first used in America were probably of German make, but it need hardly be said that the lamp manufacture was speedily developed to a gigantic extent in that country. Some of the earliest lamps for burning mineral oil in dwellings which were produced in Germany and in Scotland, possess considerable interest as ingenious devices for promoting the perfect and steady combustion of the oil, and as attempts to dispense with the necessity of the chimney for the production of a steady light. In one of these a small lamp was introduced into the base or stand of the lamp proper, and a tube passed from over this little lamp, through the oil reservoir into the burner, so as to supply the latter with heated air. In another, a small fan or blower, with simple clockwork attached, to keep it in rapid motion, is placed in the stand, and supplies the flame with a rapid current of air. Among other workers at the perfection of mineral oil lamps was the late Dr. Angus Smith, who produced a double-wick lamp some years before the beautiful duplex-lamps were first manufactured by Messrs.

Hinks. Some of the more recent American lamps exhibit decided improvements in the details of construction of the oil reservoirs, the wick-holders and elevators, the arrangement for extinguishing the lamps, &c.

It does not come within the province of this discourse to deal with the marvellous development of the petroleum industry in America, where the region of Western Pennsylvania now furnishes about 70,000 barrels of oil per day, having up to January 1, 1884, yielded a total of 250,000,000 barrels. Nor would it be relevant to enter upon the equally interesting topic of the recent extraordinary progress of the same industry in the Caucasus, which is chiefly due to Messrs. Nobel Brothers, further than to refer to the fact that the Baku petroleum lamp oil, which supplies the entire wants of Russia, and is gradually obtaining a footing in Germany, and even here, appears, notwithstanding its comparatively high specific gravity, to be adapted for use in mineral oil lamps of the ordinary construction. This seems to be partly owing to the comparatively small proportion of lamp oil that is extracted from the crude Baku petroleum, in consequence of which the variety of hydrocarbons composing that product of distillation which is used for illuminating purposes, presents a narrower range than is the case in the ordinary American petroleum oil of commerce. It has also been established by careful observations which Beilstein has instituted, that some American oil which is specifically lighter than the Baku oil is not so readily carried up to the flame as the latter, by the capillary action of the wick. Mr. Boverton Redwood has carried out some instructive experiments, employing different kinds of wick as siphons, and measuring the quantity of different descriptions of oil drawn over in corresponding periods of time by the different wicks. These showed that the Baku kerosine was drawn over with decidedly greater rapidity than samples of American petroleum of ordinary quality, but that, on the other hand, a sample of American kerosine of the highest quality exhibited a corresponding superiority over the Baku oil experimented with. The nature and behaviour of the wick plays a most important part in determining the efficiency and also the safety of a mineral oil or petroleum lamp, as will be presently pointed out.

Ever since paraffin or petroleum oils, which may be included under the general designation of mineral oils, first assumed importance as illuminating agents, accidents connected with their use have continued to claim prominence among those casualties of a domestic character which tend to cast suspicion on the safety of the material dealt with, or of the method of employing it, under the ordinary conditions fulfilled by its careful use.

The employment as an illuminant of the most volatile portions of petroleum which are classed as spirit or naphtha, has been chiefly limited to the wickless Holliday lamp, in which a small continuous supply to a chamber heated by the lamp flame which surrounds it, furnishes the vapour which maintains that flame, and to the small so-called sponge lamps or benzoline lamps, of which the body is filled with fragments of sponge, and which is intended to be charged only with as much spirit as the sponge will hold thoroughly absorbed; the small flame at the top of the wick-tube being fed by the gradual abstraction of the liquid from the soaked sponge, by the wick of sponge or asbestos which fills the tube. An ingenious application of naphtha as an illuminant consists in filling a reservoir with sponge fragments kept soaked with the spirit, the vapour of which descends by its own gravity through a narrow tube at the base of the reservoir, and issues from a fish-tail burner under sufficient pressure to produce a steady flame for some time.

(To be continued.)

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, March 12.—J. W. L. Glaisher, F.R.S., President, in the chair.—Messrs. Philip Magnus and R. Lachlan were elected Members —Mr. J. J. Walker, F.R.S., made a second communication on a method in the analysis of plane curves.—Mrs. Bryant, D.Sc., read a paper on the geometrical form of perfectly regular cell-structure. "Investigation of the properties of the rhombic dodecahedron supplies the clue to the solution of two interesting questions, which are the essential, because the pure geometrical, constituent of several questions as to actual forms in physical nature, such as the geometrical structure of compact tissues on the one hand, and the geometrical form of the honeycomb cells on the other hand. The first question is as follows:—If space were filled with spheres, and this spaceful of spheres were then crushed together symmetrically till the whole became a solid mass, what shape would each sphere ultimately assume? Since twelve is the number of spheres that can be placed round one sphere, in contact with it and with one another, it is evident that each of these ultimate solids would be dodecahedral in shape. The second question is the counterpart of the first:—If space were filled with a homogeneous solid, in which equally efficient centres of excavation were distributed uniformly, what would be the ultimate form of the cells excavated, it being supposed that when the excavators cease their work the walls of the cells are uniform in thickness? The answer to the first question is manifestly the answer to this second question also." After a geometrical discussion the author says:—"We should expect to find this dodecahedral shape in nature wherever originally spherical cells have been uniformly pressed together in a complete manner. The condition is probably seldom fulfilled, and examples are therefore difficult to find. We may look for their fulfilment, however, in the centre of a mass of soap-bubbles." The paper then considers the case of the honeycomb cells, with the conclusion: "The above explanation tends, however, to show that the bees need not be credited with any economical instinct to account for their work, but only with those simpler instincts, which enable them to carry out a joint work with perfect regularity and exactness, which simpler instincts, while sufficiently remarkable, are fairly within the limits of credibility."—Mrs. Bryant illustrated her remarks with several models of the cube and the rhombic dodecahedron.—Mr. Kempe, F.R.S., and the President (who stated that he had some few years since considered the matter from another point of view) made some interesting remarks in connection with the subject.—Prof. Sylvester, F.R.S., gave an account of a paper on the constant quadratic function of the inverse co-ordinates of $n + 1$ points in space of n dimensions; and Prof. Cayley, F.R.S., and Prof. Hart spoke on the same subject. As the hour was late Mr. Tucker (hon. sec.) merely communicated the titles of papers by Prof. K. Pearson (on the flexure of beams); Rev. T. C. Simmons (two elementary proofs of the contact of the "N.P." circle of a plane triangle with the inscribed and ascribed circles, together with a property of the common tangents); and by himself (two other proofs of the first part of Mr. Simmons's communication).

Linnean Society, March 5.—Sir J. Lubbock, Bart., President, in the chair.—Messrs. Jas. Epps, Jas. Groves and Wm. Ransom were elected Fellows of the Society.—Mr. E. M. Holmes exhibited a number of new species of British algæ, viz. thirteen from the south coast of England, and six obtained from Berwick-on-Tweed and Fifeshire. He also called attention to examples of the leaves of *Eucalyptus Staigeriana*, which are remarkable for their fragrant odour, resembling that of verbena, due to a volatile oil which is stated by Mr. Bailey, the Government botanist at Brisbane, to be likely to form an article of commerce in the future. Mr. Holmes also showed a set of plant labels made from the leaves of the Talifat palm. Mr. W. Brockbank exhibited a specimen of *Leucojum carpathicum*, a variety of *L. vernum*, differing from the type by having the flowers tipped with yellow instead of green. The *L. carpathicum* is said now to be seldom met with in English nurseries.—Mr. C. B. Plowright showed and made remarks on a Ranunculus infected with spores of *Urocystis pompholgodes*.—Mr. E. Wethered exhibited some microscopic sections of the "Better Bed" coal-seam of Yorkshire and of the "Splint" coal from Whitehill Colliery, near Edinburgh. He mentioned that Prof. Huxley had drawn attention to the former as containing in quantity sporangia and spores of plants allied to the recent club mosses. Mr. Wethered averred that these were only found in numbers in the topmost three inches of the coal-bed, but very sparsely in the lower portion of the seam. In the Edinburgh splint coal only four inches of the basal and but a part of the upper layer contained spores. Macrospores and microspores were present in both the coals, and, judging from these, he regarded them as belonging to plants resembling or allied to the recent genera *Selaginella* or *Isoëtes*. Mr. W. Carruthers replied, and dissented from this view.—Dr. F. Day read a paper on the rearing, growth, and breeding of salmon in fresh water in Great Britain. He referred to the statements and opinions of the older authorities, and then dwelt more at length on the more recent experiments of Si James Maitland at Howietoun. In December, 1880, Sir Jame obtained salmon eggs and milt from fish captured in the Teith, and which ova hatched in March, 1881. In July, 1883, it was seen that some of the young salmon, then two years and four months old, were either in the parr livery or had assumed the dress of silvery smolts, the latter in certain lights showing parr bands. On November 7, 1884, a smolt 1¼ lbs. weight jumped out of the pond, and from it about 100 eggs were expressed, and as they seemed to be ripe they were milted from a Lochleven trout.—On January 23, 1885, eighteen of these eggs hatched; the young were strong and healthy. November 11, 1884, about 12,000 Lochleven trout eggs were milted from one of the foregoing smolts, and they hatched January 28, 1885. December 1, 1884: 1500 eggs were taken from two of the foregoing smolts, and treated by the milt of one of the males. On the 9th, about 4000 eggs from these smolts were fertilised from one of the males, and on the 13th, 2500 smolt eggs were milted from a parr. Dr. Day further stated that pure salmon eggs in the Howietoun Fishery have been hatched, that the young have grown to parr, smolts, and grilse; that these latter have given eggs, and their eggs have been successfully hatched. Although time will yet be necessary before a definite reply can be given as to how these young salmon will thrive, how large they will eventually become in fresh water ponds, and whether from them a land-locked race may be expected—still the following points seem to be established. That male parrs or smolts may afford milt capable to fertilise ova; but, if taken from fish in their second season at thirty-two months of age, they are of insufficient power to produce vigorous fry. That female smolts, or grilse, may give eggs at thirty-two months of age, but those a season older are better adapted for the production of vigorous fry, where, to develope ova, a visit to the sea is not a physiological necessity. That young male salmon are more matured for breeding purposes than are young females of the same season's growth. That female salmonidæ under twenty-four months of age, although they may give ova most, are of little use for breeding-purposes, the young, if produced, being generally weak or malformed. That at Howietoun, so far, hybrids between trout and salmon have proved to be sterile. Furthermore, it was stated that the size of eggs of salmonidæ vary with the age and condition of the parent, but as a rule older fish give larger ova than younger mothers. Even among the eggs of individual fish, variations occur in the size of the ova. From larger ova finer and rapidly growing fry are produced, consequently by a judicious selection of breeders, races may be improved, but it is only where segregation is efficiently carried out that such selection is possible.—A paper was afterwards read, Notes on some recently-discovered flowering plants from the interior of New Zealand, by the Rev. W. Colenso. In this the author describes and gives field notes on some eighteen supposed new species.

Institution of Civil Engineers, March 3.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was on the construction of locomotive engines, and some results of their working on the London, Brighton, and South Coast Railway, by William Stroudley, M.Inst.C.E. The author, on his appointment to the London, Brighton, and South Coast Railway, in 1870, had to consider what kind of locomotive engine and rolling stock would best meet the requirements of the service; as, owing to the great increase and complication of the lines and traffic, the original primitive engines and rolling stock were not able to do so. He, therefore, in the same year designed a large goods engine, class "C.," arranging the detail so that they would enable him to construct the several classes illustrated, all the principal parts being interchangeable. Having had long experience with both outside- and inside-cylinder engines, he adopted inside cylinders, but placed the crankpins for the outside rods on the same side of the axle as the inside crank, the outside pin, however, having a shorter stroke; and he thus obtained the advantages of both systems. He adopted the method of putting the coupled wheels in front, instead of at the back as usual, which permitted the use of small trailing wheels, lightly weighted, and a short outside-coupling rod for the fast running engines, and also a much larger boiler than could be obtained when the coupled wheels were at the back. The author adopted a somewhat high centre of gravity, believing that it made the engine travel more easily upon the road, and more safely at high speeds; the slight rolling motion, caused by the irregularities of the road, having a much less disturbing influence than the violent lateral oscillation peculiar to engines with a low centre of gravity. The high centre of gravity also threw the greatest weight upon the outside or guiding wheel when passing around curves; and this relieved the inner wheels, and enabled them to slip readily. The author used six wheels in preference to a bogie for these engines, to avoid complication and unnecessary weight. The engines were very light for their power. Spiral springs were used for the middle axle, and these had a greater range than the end ones for the same weight. The two cylinders of the large engines were cast in one piece, with the valves placed below, giving lightness, closeness of centres, and easy exhaust and steam-passages. The crank-axle was the only disadvantage left in an inside cylinder, inside framed engine, and, when this was of good proportions, it offered but a small objection. Owing, however, to the narrow gauge of the rails in this country, the crank-axle could not be made so strong as it ought to be, or there would be no reason why a crank-axle should break. When the flanges of the driving-wheels were turned down thin, so as to avoid the side-shock given by crossings and check-rails, there only remained the strain of the steam upon the pistons to cause breakage; the action of this was precisely the same as the methods used by the late Sir William Fairbairn in testing to destruction the model tube for the Menai Bridge, by letting a heavy weight rest upon it suddenly at frequent intervals. The deflection, if sufficient, caused a crack at the weakest place, which gradually extended until fracture took place. This was precisely what occurred in the axle; the crack invariably commencing on the side of the axle opposite to that to which the steam was applied. The author, after thirty years' experience, believed that the separate parts of locomotives, including tires, axles, piston-rods, side-rods, bolts, cotters, and carriage and wagon axles, broke from the same cause; they did not break when carefully designed, and made with proper materials and workmanship. As the crank-axle could not be made of the proper strength, it was well to consider how to avoid, as far as possible, risk of accident by its failure. By making the axle-boxes and horn blocks deep and strong, giving large flat surfaces against the boss of the wheel and the outside of the crank arm, the driving-wheel was kept in position after the axle was broken, if the fracture occurred in the usual place, namely, through the inside web, near the crankpin, or through the centre part where it joined the inside web. An axle, broken in this manner, would run safely over any part of the road, except at a through-crossing, where the guiding-rail was lost, and the flange was liable to take the wrong side of the next point; this, however, had not happened in the author's experience. The author had always hooped the larger cranks, and had for some time hooped every new crank in the same proportion as adopted on the Great Northern Railway, thus reducing the risk to a minimum. The engines had been arranged that part of the exhaust steam might be turned into the tender or tanks, so that the feed-water might be heated. This was a special advantage in a tank engine, by increasing the total quantity of water; it also kept the water supply of greater purity, and it relieved the boiler of a certain amount of duty in heating the water from the ordinary temperature to that which feed-water required. The feed-pumps had been designed to meet the requirements of pumping hot feed-water. The proportions of the valve-gear gave an admission of 78 per cent. of steam in full gear, which could be reduced to 12 per cent. with excellent results; and as at high speeds the steam was never exhausted, the temperature of the cylinder was maintained, and as much steam was locked up in the cylinders as raised the pressure at the end of the stroke to near that in the steam chest. This made the engine run very smoothly at high speeds, and turned what would otherwise be an extravagant coal-burner into an economical machine. And for the same reason the compounding of fast-passenger or frequent-stopping locomotives was not likely to show much, if any, economy over a well-designed, simple engine. The case was different, however, in heavy goods engines, working with a late cut-off most of the time, and where the conditions approximated closely to those of a land or marine engine with a constant load. The back-pressure observed in the diagrams of high-speed locomotives was not therefore a defect, but an advantage, and the author accordingly used small steam-ports and short travel of slide-valve. These remarks as to back-pressure did not apply to the pressure in the exhaust pipes, where it should be as small as possible, but only to the back-pressure in the cylinder. The latter was greatest at high speeds, when a small volume of steam was passing through the cylinders, and small power was required, and least when working full power with the smallest expansion. All the passenger engines and many of the goods engines were fitted with the Westinghouse automatic air-brake, as were also the whole of the carriages. This brake gave entire satisfaction and complete control of the trains. The author took considerable pains with the fittings and details when it was first introduced, and arranged the gear for the engines, so that the brake acted upon each wheel independently, allowing the springs freedom to act; or it acted upon the front of all the wheels, as in the tank engines, the brake of which was moved by hand as well as by the air-pressure. The Westinghouse air-pump had been fitted with a plunger at the bottom end of the rod, $1\frac{3}{4}$ inches in diameter, and this pumped water into the boilers of the goods engines when they were in sidings or were delayed by signals. For the express and large goods engines the greatest possible amount of heating-surface had been provided; the fire-box was capacious, with small tubes of considerable length in proportion to their diameter, little or no flame being generated with the coal used, and a very small amount of soot. The fuel which was found cheapest to consume in this locality was smokeless coal from South Wales, mixed with a small quantity of bituminous coal from Derbyshire. The boilers were made of the best Yorkshire iron, with plates having planed edges; holes were drilled after the plates had been bent; the joints were butt-joints, and they were hand-riveted. The construction of the ash-pan and its dampers, perforated plates, water-supply, and the arrangement of fire-bars, brick arch, fire-door, and deflector, was shown. The indicator diagrams, taken by one of the Crosby Steam-Gauge and Valve Company's indicators, at various speeds, and under varying conditions of gradient, afforded a fair idea of the working capabilities of these engines, the economical value of which was best shown by quoting the consumption of fuel for the half-year ending June 30, 1884, when the average of the whole of the engines on this line was 29·74 lbs. per engine mile, including the coal used in raising steam. A great number of careful tests had been made of the amount of coal required to raise steam in the engines from cold-water, and also from the partially heated water when the boiler had not been emptied, and this amounted on an average to about 3 lbs. per mile run. Some doubts had been expressed as to the value of heating feed-water by the exhaust steam. The author, therefore, had a number of tests made with the ordinary heating-apparatus removed, and water fed to the boilers by the feed-pumps, and in one series by a Borland's injector. The amount of power required to work the pumps was inappreciable; and the heated feed-water brought about reduction in the consumption of fuel to the extent of over $2\frac{1}{2}$ lbs. per train-mile. It had also been found that heating the feed-water by direct contact of the steam did not, on this railway, injuriously affect the boiler-plates. With a view to ascertain what was the amount of power required to haul a train from Brighton to London, a complete set of 49 diagrams was taken from the engine "Gladstone," working an express train of twenty-three vehicles; the total weight of train and engine being 335 tons 14 cwt. A section of the line was given, and clearly illustrated the result, giving the H.P. at about every mile, the speed, and the gradient. The temperature of the gases in the smoke-box was taken at frequent intervals; also the degree of vacuum in the fire-box and in the smoke-box, and the quantity of water used out of the tender. To the latter had to be added the water condensed from the exhaust, which, from experiments, the author estimated at 20 per cent. This gave an evaporation of 12·95 lbs. of water per 1 lb. of coal, and 1 lb. of coal would convey 1 ton weight of the train $13\frac{1}{4}$ miles, at an average speed of 43·38 miles per hour, over the Brighton Railway, the rate of consumption being 2·03 lbs. of coal per H.P. per hour.

Chemical Society, March 5.—Dr. W. H. Perkin, F.R.S., President, in the chair.—The following papers were read:—On the conversion of Pelouze's nitrosulphates into hyponitrites and sulphites, by Prof. E. Divers, M.D., and Tamemasa Haga.—On the constitution of some non-saturated oxygenous salts and the reaction of phosphorus oxychloride with sulphites and nitrites, by Prof. E. Divers, M.D.—The illuminating power of hydrocarbons. I. Ethane and propane, by Percy F. Frankland, Ph.D., B.Sc.—On benzoylacetic acid and some of its derivatives, Part III., by Dr. W. H. Perkin, jun.

Anthropological Institute, March 24.—Francis Galton, F.R.S., President, in the chair.—The election of the following gentlemen was announced:—F. D. Mocatta, the Hon. Cecil Duncombe, J. G. Frazer, M.A.—A paper was read by Mr. A. J. Duffield on the inhabitants of New Ireland and its archipelago. The author first dealt with the assumption that the inhabitants of these islands are the descendants of remote but superior races, that they retain inherited powers which have become weak by lack of use, and that these moral and intellectual powers can be easily restored. The food of the natives is chiefly vegetable, but they now and then eat the flesh of the small native swine—the opossum—and poultry, which is abundant. The climate is humid and unhealthy; the people poor in flesh, small in size, and light in weight. Their usual colour is a dark brown, but they are a mixed race; the hair is crisp and glossy. The tattooing and cuttings on the flesh are confined to the women and the headmen. The men go absolutely nude, but the women wear "aprons" of grass before and behind, suspended from cinctures made of beads strung on well-made thread; they bleach their hair and paint their bodies with coloured earths. They speak a language which is at once musical and familiar, in which is found a fair sprinkling of Arabic and Spanish words.—Mr. R. Brudenell Carter read a paper on vision-testing; and Mr. C. Roberts read a paper on the same subject.

DUBLIN

Royal Society, January 19.—Section of Physical and Experimental Science.—Prof. C. A. Cameron, M.D., in the chair.—Prof. Emerson Reynolds, M.D., F.R.S., gave a short account of the selenium analogue of the sulphur urea—thiocarbamide—he discovered some years ago. The author, having recently prepared a considerable quantity of cyanamide, and being aware that other chemists had failed to produce selenocarbamide by the molecular change of ammonium selenocyanate, decided to examine the action of hydrogen selenide on cyanamide, as it is well known that thiocarbamide can be easily formed according to the equation $H_2S + \left.\begin{matrix} CN \\ H \\ H \end{matrix}\right\} N = CS''\left\langle\begin{matrix} NH_2 \\ NH_2 \end{matrix}\right.$. F.... grams of cyanamide were dissolved in 50 ccs. of anhydrous ether and a slow current of hydrogen selenide was passed through the solution under a pressure of about 60 mms. of mercury. The gas was slowly absorbed, and at first some selenium separated from the liquid, but on continuing the treatment beautiful colourless crystals separated on the sides of the vessel. The crystals were drained from the etheral liquid, and when exposed to the air were found to be easily reddened by the action of light; they were dissolved in a small quantity of hot water, the solution filtered, and then cooled, when beautiful silky crystals separated which very closely resembled thiocarbamide in appearance and mode of crystallisation. The purified compound proved to be $CSe(NH_2)_2$. The author learned, however, from the January number of the *Journal* of the Chemical Society of London that M. A. Verneuil had just published an account of the same body in the *Bulletin* of the Paris Society. Dr. Emerson Reynolds, therefore, did not continue his investigation, as he believed M. Verneuil to be fully entitled to priority, but contented himself with the exhibition to the society of the specimen of selenocarbamide produced in the Dublin University Laboratory.—On a model illustrating some properties of the ether, by Prof. G. F. FitzGerald, M.A., F.R.S. The model consisted of a series of wheels arranged at equal distances along parallel rows on axes fixed perpendicularly into a board. The wheels were connected together by indiarubber bands, each wheel being so connected with its four neighbours. Under these circumstances it was shown that if any wheel were turned all the wheels turned simultaneously, and that, except for friction on the axes, &c., they would all turn equally. It was explained that the model only exhibited properties of the ether itself and did not exhibit the connections of matter with ether. A region within which the bands did not slip represented a non-conducting region, and differences of elasticity of the bands represented differences of specific inductive capacity, slipping of the bands represented a conducting region, and complete absence of bands represented a perfectly conducting region. When bands were removed from a certain region and all around it a line of bands left, and all around outside this again a conducting region, then if a conducting line connected these regions the wheels along this line might be turned in opposite directions, and when this is done all the non-conducting region is thrown into a state of stress by all the wheels not rotating equal amounts, in which the bands are tight on one side of a pair of wheels and loose on the opposite side. It was explained that this exhibited the polarisation of the medium between two oppositely charged conductors, the direction of polarisation being at right angles to these bands—*i.e.*, in the line joining the conductors—the medium in this state representing a charged Leyden jar, the two opposite electrifications being represented by the tight and loose bands, one conductor being bounded entirely by tight bands and and the other by loose ones, and the electric displacement of Maxwell being represented by the difference between the two sides of a band. If the bands along any line between the two conductors slipped, all the energy of the medium was spent along this line in friction, and this represented a discharge along the line. This energy was conveyed into the line of discharge by its side and not along its length in accordance with what Prof. Poynting has recently shown to be the case in all electric currents. If the resistance along the line of discharge were sufficiently small the momentum of the wheels would carry them beyond their position of equilibrium and the well-known phenomenon of an alternating discharge would be represented. This led to the observation that the magnetic displacement was represented by the angular velocity of rotation of the wheels and the self-induction by their momentum. It was remarked that the mechanical attraction between the two conductors was not represented, but it was explained that as this depends on the connection of matter with ether it would require more complicated mechanism. It was, however, pointed out that by supposing the wheels slightly distorted by the stress, and by supposing a thread wound around them and each end connected with the material of a conductor, a force would be produced drawing the conductors together owing to the circumference of a distorted wheel being longer than of an undistorted one. This force would be proportional to the square of the distortion, a necessary condition not satisfied by ordinary stresses, and would be, if exerted between two infinite planes, independent of their distance apart, and so must represent a force varying inversely as the square of the distance. Returning to the electric currents, it was shown that by turning the wheels at any point of a conducting circuit the whole region was filled with turning wheels—*i.e.*, with magnetic displacement—and that, if a resistance were introduced at any point of the circuit, the energy would be transferred to that point through the medium and enter by the side of the conductor. If two independent conducting circuits existed near one another it was shown that the phenomena of induced currents were represented. It was explained that the mechanical force was not represented, as it depended upon the connection between matter and ether, but that it might be looked for as in some way depending on the centrifugal force arising from the rotations. The equations representing the energy of the model are of the same form as those of Maxwell representing the energy of the ether when limited by the consideration that the model was only in one plane. It was explained that a tridimensional model whose energy could be represented by the same equations as Maxwell's could not be constructed with indiarubber bands, but might be constructed by means of wheels pumping fluid through pipes. This led to the observation that the propagation of waves by transverse vibrations could be illustrated by the model, and it was explained how a sudden turning of any set of wheels would start a wave-propagation whose direction of propagation was at right angles to the directions of magnetic displacement and of electric displacement, the former represented by the axes of rotation and the latter by the line joining the centres of a tight and loose band. It would be possible theoretically to construct a model illustrating the laws of reflection and refraction of light even at the surfaces of crystalline media, and to reproduce conical refraction. It was explained that by twisting the medium the rotatory polarisation of quartz might be represented, and that probably a mechanism might be introduced by which the rotation of other wheels or of something besides the wheels being altered by the rotation of the wheels, a reaction of the former on the latter would reproduce magnetic rotatory polarisation. It was pointed out that both magnetic rotatory polarisation and dispersion were due to a reaction of the medium during the wave-propagation and not to a change of the medium independent of the wave-propagation. It was explained that it was not to be supposed that the ether was constructed of wheels and indiarubber bands, nor even of wheels pumping fluid in pipes, but it was pointed out that some properties of the ether might be gathered from the model if it be assumed that the qualities of the ether represented by symbols obeying the laws of rotation for instance are really of the nature of rotation. If this be so the ether must be such that any part of it can rotate as often as it likes provided all the neighbouring parts rotate equally and the electrostatic stresses in the ether must be due to the difference of rotation of its parts. If the ether be a perfect liquid it can only have such properties as represent rigidity by being in motion, and it was explained that many electrical phenomena might be illustrated by the polarisation of the vortical motions in a vortex-sponge. Sir Wm. Thomson has pointed out that such a state of polarisation as a single vortex region in the centre of a cylindrical box will not of itself change unless it can spend its energy on the box, which is quite analogous to the fact that the energy of the polarisation of the ether does not disappear unless it can produce heat or mechanical or other forms of energy. It was also pointed out that forces depending on small vortices vanished at small distances from them and that hence the forces depending on their polarisation between two infinite planes would depend on the polarisation and not on the distance between the planes, and so must be of the nature of forces varying inversely as the square of the distance. It was explained that the modes of polarisation of vortices were sufficient to explain both electrical, magnetic, cohesional and chemical forces. It was finally reiterated that the only possible way of giving anything of the nature of rigidity to a perfect liquid was by conferring motion on it and that it seemed likely that any mechanical properties could be conveyed by suitably chosen motions. This was quite in accordance with Sir Wm. Thomson's suggestive address to Section A at Montreal.

Natural Science Section.—V. Ball, M.A., F.R.S., in the chair.—On the physical characters of calcareous and siliceous sponge spicules and other structures, by Prof. W. J. Sollas, M.A., D.Sc., F.R.S.E., F.G.S.—The refractive index of a siliceous sponge spicule, diatom, or other siliceous organic body is determined by immersing it in liquids of different refractive indexes until one is found in which it ceases to be visible under the microscope. The refractive index of this liquid gives that sought for. The siliceous matter of organisms has a refractive index of 1·449, which is that of some kinds of opal or colloidal silica. The refractive indexes of calcareous sponge spicules are found in a similar manner, but as these are biaxial it is necessary to examine them between crossed Nicols; $r_\epsilon = 1{\cdot}485$, $r_\omega = 1{\cdot}659$. These indexes agree with those of calcite. This method of obtaining refractive indexes is applicable to mineral bodies; the glass of the Krakatoa explosion is thus found to have a refractive index of 1·51. Leucite can be thus readily distinguished from analcime and calcite from aragonite. The specific gravity of calcareous spicules (1·62) and that of foraminifera were found by an adaption of the Sonstedt solution method to use with the microscope. The perforate foraminifera have a sp. gr. of 2·65 to 2·67, the imperforate of 2·7 to 2·72, calcite being taken as 2·7. The structure of calcareous spicules was shown by a study of the extinction angles between crossed Nicols, by the development of cleavage planes, and each figures to be purely crystalline. Each spicule is a single calcite individual with its optic axis definitely related to its form. The acerate spicules of calcisponges are distinguished from those of the siliceous sponges by their form, the former often presenting an oval or rhomboidal transverse section. The large spicules of the Pharetrones agree with those of the Calcisponges, with which, therefore, this fossil group must be associated.—On some Trilobites from the Cambro-Silurian rocks of the County Clare by W. H. Baily, F.C.S.—Notes on the coalfields of Leinster and Tipperary by G. H Kinahan, M.R.I.A.

CAMBRIDGE

Philosophical Society, March 2.—Prof. Foster, President, in the chair.—The following communications were made:—On some theorems in tides and long-waves, by the Rev. E. Hill. Elementary considerations were given from which it might be inferred that when a disturbing body produces a semi-diurnal tide in an equatorial canal, the point nearest to the disturbing body will be a point of low tide or high tide according to the depth of the canal. A general explanation was given of the influence of the depth of a canal on the speed of a long wave traversing it. It was shown that the ordinary formula for this speed might be deduced from the ordinary differential equation of motion without integration.—On the electrical resistance of platinum at high temperatures, by Mr. W. N. Shaw.—On an automatic mechanical arrangement for maintaining a constant high potential, by Mr. Threlfall. A water-motor of the Thirlmere type is allowed to settle down to a constant velocity by means of the resistance of a fan which is worked by the motor.

The motor thus governed rotates a shaft on which is a copper disk and two pulleys. The copper disk is placed between the poles of a large electro-magnet: and the second pulley serves to give motion by means of an india-rubber band to a replenisher whose dimensions are determined by the special conditions of the experiment for which the apparatus is to be employed. The regulator, mounted on a box in which is a condenser, consists of a fixed and movable disk, the latter suspended from a spiral spring and carrying a wire across its back turned down at its two ends. The disks are connected with the poles of the condenser, the movable one being put to earth. By means of a Weber suspension arrangement mounted on the top of a guard-hole which protects the spiral spring from currents of air, the attracted disk can be adjusted so that when the difference of potentials arrives at the required value, the wire dips into two mercury cups and so short-circuits a high resistance. By this means a strong current is allowed to flow through the electro-magnet and act as a brake on the copper disk; this causes the velocity of the engine to change and a replenisher to revolve more slowly. When the potentials have fallen sufficiently by leakage or otherwise, the contact at the mercury cups is broken and the motor is enabled to rotate at a higher rate of speed. By this means the potential difference is kept between certain limits depending on the sensibility of the arrangement, and this is increased by having the disks close together and the contact points made of aluminium instead of platinum. Such an apparatus is of use in maintaining condensers, &c., subject to leakage at a constant high potential.

PARIS

Academy of Sciences, March 16.—M. Bouley, President, in the chair.—Reaction of bromine on the chlorides and on hydrochloric acid. A new class of perbromides by M. Berthelot. Fresh experiments made by the author show that the reaction of bromine on the chlorides always liberates heat in the same way as the inverse reaction. In both cases the transformation of the system is always exothermic. Hydrochloric acid and highly concentrated chlorides dissolve bromine in large quantities with liberation of heat, attesting the existence of combinations formed by addition (perbromides of chlorides).—A morphological comparison of Limax (*L. Agrestis, Cimereus* and *Gagates*) with Testacella (*T. haliotidea* and *Maugey*), by M. H. de Lacaze-Duthiers.—On the solubility of the sulphurets of carbon and of chloroform, by MM. G. Chancel and F. Parmentier. The solubility of the sulphuret of carbon in water is shown to diminish according as the temperature is raised. But that of chloroform presents a decreasing solubility from 0° to about 30° C., thenceforth increasing towards its boiling-point.—On the influence of the perturbations in determining the orbits of celestial bodies, by M. E. Vicaire.—A reply to M. Boiteau on the treatment of phylloxera and its winter eggs by washings and sulphur, by M. P. de Lafitte.—Records of the Scientific Mission to Cape Horn (1882–83); Vol. ii. Meteorology, by M. J. Lephay.—Note on the Abelian functions, by M. H. Poincaré.—On the theory of matrices, by M. Ed. Weyr.—On the canonical types of the ternary quadratic forms of differentials whose discriminant is null, by M. G. Königs.—On the electric differences between fluids, and on the part played by the atmosphere in the electrometric measurement of these differences, by MM. E. Bichat and R. Blondlot.—A thermo-chemical study of the fluosilicate of ammoniac: action of the fluoride of silicium on the fluoride of ammonium, and on ammoniac, by M. Ch. Truchot.—Description of a new process for hardening plaster of Paris, by M. Julhe. By the process here described a plaster is produced which may be substituted for wood in floorings, being equally durable and four times cheaper than oak.—Bromuretted substitution of phenolic hydrogen: bromuretted tribromophenol, by M. E. Werner.—On Fromherz's fluid, by M. E. J. Maumené.—On the chemical composition and therapeutic properties of *Artemisia gallica*, Wildenow, by MM. Ed. Heckel and Fr. Schlagdenhauffen.—Physiological action of the hexahydride of β-colladine or isocicutine, by MM. Rochefontaine and Œchsner de Coninck. From experiments made on the frog and guinea-pig the authors find that this substance possesses a physiological action analogous to that of the alkaloid of hemlock (Cicuta). Hence they propose the alternative name of "isocicutine," recalling at once its chief chemical and physiological properties.—Definition, classification, and notation of colours, by M. J. Charpentier. A system of notation and classification is suggested, by means of which a thousand colours may be formulated by the series of natural numbers from 0 to 999, where each cipher takes a precise meaning in virtue of its position. The name of the colour would simply be that of the number symbolising it, and the system might be called the "cubic classification," from the geometrical representation by which it may be best figured.—On the glands and lymphatic vessels entering into the constitution of the organ in birds known as the purse of Labricius, by M. Retterer.—On the physiological effect produced by the action of turning eggs during incubation, by M. Dareste. From experiments made with artificial incubators, the author finds that eggs not turned two or three times a day all perish invariably. The effect of this act on the embryo is explained, and the action of the bird accounted for on strictly physiological grounds.—Ores of the carbonate of zinc: their normal association with dolomitic formations explained, by M. Dieulafait.—On the Miliolideæ of the Chalk formations, by MM. Munier Chalmas and Schlumberger. Idalina, Periloculina, and Lacazina, three new genera from the Upper Chalk of Provence, are described and affiliated to the family of the Miliolideæ.—The channels and lagoons on the east coast of Madagascar, by M. A. Grandidier. These inlets and lacustrine formations are explained by the position of the main water parting, which is usually placed about the centre of Madagascar, but which the author shows is situated much nearer to the east than to the west coast.

VIENNA

Imperial Academy of Sciences, January 22.—On the analysis of andesin of Frifail (Carinthia), by R. Maly.—On the self-purification of natural waters, by F. Emich.—On the action of bile acids on glutin and glutin "peptones," by the same.—On the products obtained by reduction of nitroazoic bodies, and on azonitrilic acids, by J. V. Janovsky.—On the astronomical knowledge of the South Arabian Cabyles, by E. Glaser.—On dehydracetic acid, by L. Haitinger.—Geological researches on the grauwacke formations of the North-East Alps, especially regarding the Semering region, by F. Toula.—On the meteorological observations made at the Austrian arctic station at Jan Mayen during 1882 and 1883, by A. Sobiezky.—On tide observations made in 1882–83 at Jan Mayen, by A. Bobrik.—On the survey of Jan Mayen carried out by the Austrian Arctic Expedition, by the same.

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