THURSDAY, APRIL 10, 1879

JOHANNES MUELLER'S CLASSIFICATION OF PASSERES

Johannes Müller on Certain Variations in the Vocal Organs of the Passeres that have hitherto escaped Notice. The Translation by F. Jeffrey Bell, B.A. Edited, with an Appendix, by A. H. Garrod, M.A., F.R.S. (Oxford, at the Clarendon Press, 1878.) 4to. Plates.

MORE than thirty years ago was this celebrated treatise, now translated by Mr. Bell, published, but without attracting any notice in this country. It is true that some twelve months after the author's investigations were first communicated to the Academy of Sciences of Berlin (June 26, 1845), a brief abstract of them appeared in what was then, as it still is, our leading biological magazine (*Ann. Nat. Hist.*, xvii. p. 499), but no one here seems to have thought them worthy of further attention. Indeed, the principal British ornithologists had so long gone astray in pursuit of that will-o'-the-wisp—the "Quinary System," which seemed to have been revealed to the obscure vision of Vigors, and had so completely mystified themselves with hazy speculations concerning circles, types, affinities, and all the jargon of what was so loudly proclaimed to be *the* "Natural Arrangement," that it would have been hopeless to expect them to return to the paths of common sense. Their successors had to make the best of what was before them, and that best was obviously to leave it alone: for they doubtless found, even as we find to day, that all which had been written by the Quinarians was hopelessly unintelligible.[1] Preached, however, as this doctrine constantly was, amid terrific maledictions on all who hesitated to receive the "Circular System" as the orthodox faith, they were content to let its results pass unquestioned, and thus the "Natural" Orders and other groups, which were the invention of Vigors and some of his followers, were silently accepted, and they continued to be adopted by most British ornithologists until very recently, if indeed they have now gone wholly to their rest. There is nothing extraordinary in all this. No disputant is so difficult to overthrow as a mystic, and a mystic your Quinarian certainly was. He could, moreover—and the fact is worthy of note, since mystics are seldom so highly accomplished—write long and smooth sentences, irreproachable as to style or grammar, generally not deficient (allowance being made for certain false premisses) in logical arrangement, sometimes distinctly marked by wit, and always abounding in metaphor. They only lacked a plain meaning. If you pleaded that it was not easy to distinguish the boundaries of the metaphorical and the real, he politely intimated in reply that you were an ass, and deluged you with another torrent of mystic verbiage of the same kind. On raising further objection, your Quinarian began to lose his temper, and, metaphorically shaking "a bunch of fives" (namely, his fist) in your face, discharged at you a volley of well-assorted epithets, about the reality of which there could be no doubt. This is absolutely no exaggeration of some of the characteristics of the Quinarian controversy which may be found in certain publications since 1823, when Vigors unhappily began to apply to Ornithology the senseless fantasies which Macleay had a short time before evolved from the depths of his own imagination. Good work, very good work, was no doubt being done in the meanwhile by some British ornithologists, but the good work was wholly of a limited and special kind. Generalised or broad views were either not taken at all, or, if attempted, were propounded by men of comparatively poor ability, men who were unable to see their way through the baleful fogs that the Quinarian magicians had conjured up around them. It is not too much to say that for some forty years British ornithologists were wandering in a wilderness of words. Temminck's "Manuel d'Ornithologie," the second edition of which was published in 1820, and speedily became well known in England, it is true, kept some, who regarded it as a kind of gospel, from being utterly bewildered by the cloudy dreams of the Quinarians, for Temminck was a simple-minded Dutchman, who had no philosophical or pseudo-philosophical theories to support, no circular visions to relate, and no metaphorical phrases wherewith to encumber his statements. He wrote in French, and if his language appeared to Vieillot not to be the pure French of the Académie Française, it was easily understood by most Englishmen, and he consequently exercised an enormous influence on their mind—an influence which in time produced evil effects, though that is at present no business of ours to show.

During this period of darkness in England there were, however investigators in other lands pursuing what is now obvious to all to have been the right road. Unfortunately their investigations were published so as to be practically inaccessible to our countrymen, and the results at which they arrived were utterly unknown to British ornithologists. Thus we find Strickland, by far the best-informed man of his calling and time, saying, in 1844, that the labours of Wagler[1] and Nitzsch "have not fallen under my inspection." Accustomed as we are in these days to the rapid exchange of publications with our continental brethren, we might regard this at first sight to be a grave shortcoming, but commercial and postal facilities of intercourse with fellow-workers in foreign countries did not exist, and we are prepared to maintain that no very great blame is to be ascribed to British ornithologists of that epoch for not knowing what was being done abroad. The fault lay beyond them. There was first the heavy import duty on foreign books, which pre-

[1] The Quinarian system has so completely dropped out of use, that readers of this generation may be at a loss to find out what it really was. We therefore present them with the following "Symbolum Fidei," drawn up by a very orthodox Quinarian (Mr. Neville Wood), in 1836, in the hope that it will convey clear ideas to them:—"The first and fundamental principle inculcated by Macleay and his disciples is, that all nature moves in a circle, and that the series of beings is unbroken; and, secondly, that each group and each species has a double affinity. Every one of the higher groups has a binary division, viz. the normal or typical, and the aberrant, the former containing two, and the latter three, of the five subdivisions of which each of the higher groups is composed. We cannot here explain the doctrine of *analogy*—which is wholly distinct from affinity—but we can give an instance of it:—the Hedge Dunnock in the *Sylviadæ* represents the House Sparrow in the *Fringillidæ*; that is, the one bears the same relation to the *Sylviadæ* that the other does to the *Fringillidæ*, and *hence* they are said to bear an analogy to each other. The whole zoological series, before arranged in a simple chain, according to this system revolves in an almost infinite number of circles around man, from whom they may be said to degrade on all sides." It is pleasing to observe that a little further on the author states that "no one who supposes the Quinary System, or any part of it, to lead to Atheism, can rightly understand its principles."—*Ornithologist's Text-book*, pp. 30, 31.

[1] Referring probably to his "Natürliches System" of 1830, for his "Systema Avium" of 1827 had long before been reviewed in England (*Zool. Journ.* iii. p. 465).

vented international booksellers from existing, and made it far more difficult to obtain in London a work published in Paris or Leipzig than it now is to get one that has been printed in Chili or Japan. Next—perhaps it should have been placed first—there was the lamentable fact that so defective was English education, that few boys were taught to read a book in any modern language but their own. Enormous time was wasted at school over Greek and Latin, which, owing to the senseless method of teaching, were, as now, scarcely ever taught to any useful purpose. A smattering of French was sometimes picked up by boys when at home for the holidays, but that was all. German was an utterly unknown tongue. All this is of course notorious. To the ordinary English gentleman it mattered nothing, nor did it signify very much to the literary man, but on the man of science its effect was disastrous, and especially was it so to the naturalist. Most of Cuvier's works had been, it is true, translated, so they were open to all, but this was a very exceptional case. Probably no British ornithologist had ever heard of Merrem, Tiedemann, or Meckel; assuredly no British ornithologist was acquainted with their writings. Yarrell, Macgillivray, and Blyth had each made some advance in certain directions, and the last two were unquestionably not fettered by Quinarian bonds, but their advance was rather that of scouts than that of permanent occupiers. Later came Nitzsch, Dr. Cabanis, and the illustrious author of the work under review—in Germany, and—in Sweden, Sundevall; but still no effect was produced on our insular mind.

It was Nitzsch who first began the great work of critically examining the Linnæan Orders, *Passeres* and *Picæ* —the very names of which had passed out of use and were well nigh forgotten in this country, being superseded by the term *Insessores*. In his anatomical contributions to Naumann's excellent "Vögel Deutschland's," a work still far from being appreciated in England, in his treatise on the Carotid Artery of Birds—which unfortunately yet remains in the obscurity of its original Latin, and much more completely in his "Pterylographie"—edited after his death by Dr. Burmeister, and only translated into English for the Ray Society in 1867—the most important structural differences and affinities between the various forms so classed by Linnæus were clearly shown. The Order *Passeres* (or *Passerinæ* as Nitzsch called it) was revised and reconstructed, some genera being added and others excluded, while a majority of the Linnæan *Picæ* became the *Picariæ* of Nitzsch—a very heterogeneous assemblage it must be allowed—the old name being unsuitable, since the genus *Pica* was found to be truly Passerine. But Nitzsch had the opportunity of dissecting but few if any of the New-World forms, and consequently he did not know that many American *Passeres* differed essentially from those of the Old World in the structure of their vocal organs. This fact it seems was first ascertained by Macgillivray,[1] but he did not see its importance, which was really recognised by Müller, and the latter's discovery was the cause of the treatise now translated for us after so many years by Mr. Bell, and edited by Mr. Garrod.

[1] Müller in the work under review (Transl., pp. 5 and 6) makes the mistake, which his translator or editor might, we think, have corrected, of attributing the anatomical portions of the "Ornithological Biography" to Audubon! They are admittedly by Macgillivray, who is known to have also helped largely in the composition of that work.

Though ornithologists have by no means followed up Müller's investigations as they deserved, the period that has elapsed since their publication has not been altogether idly passed, and Mr. Garrod has enhanced the value of his coadjutor's translation by adding thereto an appendix bringing the knowledge of the subject almost "up to date," and incorporating the results of his own labours thereon. Müller, however, was no more free from error than his predecessors had been. He divided his "*Passerinen*"—to which he applied the Vigorsian title of *Insessores*—into three tribes:—(1) the *Oscines* or *Polymyodi*, "having the lower larynx formed partly by the trachea and partly by the bronchi, and possessing five or six pairs of muscles attached to the end of certain of the bronchial rings"; (2) the *Tracheophones*, "with the lower larynx formed exclusively by a modification of the lower part of the trachea"; and (3) the *Picarii*, "with the larynx either partly tracheal and partly bronchial, or wholly bronchial and with not more than three pairs of muscles."[1] The *Picarii* of Müller, however, form a group not quite commensurate with the *Picariæ* of Nitszch, and this is a point to which attention should be directed, as, owing to the very slight difference between the two names, one has been frequently written for the other, and the two groups deemed to be identical. Nitzsch very properly excluded what are now known as the *Tyrannidæ* from his *Picariæ*, while Müller, as improperly, included them among his *Picarii*. Both authors also erred in their conception of the family *Ampelidæ*, which, in the sense in which it is used by them comprises two very distinct groups, the *Ampelidæ* proper and the *Cotingidæ*. Nitzsch, whose experience had lain with the single European representative of the former, placed the family among his *Passeres*, while Müller, judging it would appear from the New-World genera, which are now more rightly held to compose the *Cotingidæ*, referred the family to his *Picarii*. It is nowadays abundantly clear that the true *Ampelidæ* are very normal *Passeres*, while the *Cotingidæ* are not *Passeres* in the most restricted sense. But it is impossible for us here to go into details. Mr. Garrod's appendix will show how and to what good purpose he, with the abundant opportunities he has enjoyed, has followed Müller's line of research, and has greatly extended it. We certainly wish he had more explicitly set forth, in a tabular form for instance, the general results of his continuous investigations. The want of some such summary is the only serious complaint we have to make against this book; and, regretting as we do its absence, we think we can perceive what has possibly been the motive of his abstention—his consciousness that there is yet much more to be done, that few conclusions drawn at present can be otherwise than general, and that fewer still can be final. On one important point, however, he corroborates what we imagine to have been a singularly interesting discovery of Prof. Huxley's, namely, the divergence of *Menura* (the Lyre-bird) from almost all the other *Passeres*, its only relative (and the relationship can hardly be very close) being *Atrichia*.

Our sincere thanks, and those of every English-speaking ornithologist, are due to all concerned in this book—to Mr. Sclater, whose influence with the Clarendon Press

[1] These definitions are taken from Prof. Huxley (*Proc. Zool. Soc.*, 1867, p. 471), being expressed with his usual admirable terseness.

Delegacy caused it to be undertaken; to Mr. Bell, who seems to have very efficiently performed the actual task of translation;[1] to Mr. Garrod for the Appendix already mentioned; and last, though not least, to Prof. Peters for supplying the use of the very plates which illustrated Müller's work.

OUR BOOK SHELF

Proceedings of the London Mathematical Society, vol. ix. (November, 1877, to November, 1878.) 279 pp. (Hodgson and Son, Gough Square, 1879.)

We have, in previous notices, indicated the character of the papers contained in former volumes, and the same remarks apply equally well to the volume before us. We shall content ourselves, in our present notice, with giving the titles and author's names only of the more important papers.

Prof. Cayley, not so large a contributor as usual, furnishes a short paper "On the Geometrical Representation of Imaginary Quantities, and the Real (m, n) Correspondence of Two Planes," and another equally short, "On the Theory of Groups." There are brief notes "On a Generalised Form of Certain Series," by Mr. Glaisher; "On the Transformation of Elliptic Functions," by Dr. Klein, of Munich; "On Certain Extensions of Frullani's Theorem," by Mr. C. Leudesdorf; "The Flexure of Spaces," by Mr. C. J. Monro; "On the Relation between the Functions of Laplace and Bessel," by Lord Rayleigh; "Notes on Normals," and "The Decomposition of Certain Numbers into Sums of Two Square Integers by Continued Fractions," by Mr. S. Roberts. Longer papers are: "On the Singularities of the Modular Equations and Curves," by Prof. H. J. S. Smith; "On Partial Differential Equations with Several Dependent Variables," and "On a General Method of Solving Partial Differential Equations," by Prof. Lloyd Tanner; "A Method in the Analysis of Plane Curves," by Mr. J. J. Walker; "On Conjugate Four-piece Linkages," by Mr. A. B. Kempe; and "A New Method of finding Differential Resolvents of Algebraical Equations," by Mr. R. Rawson. M. Halphen contributes a long and valuable paper on "The Characteristics of Systems of Conics."

Physical papers are "On the Electrical Capacity of a Long Narrow Cylinder, and of a Disk of Sensible Thickness," by Prof. J. Clerk Maxwell; "On the Conditions for Steady Motion of a Fluid," by Prof. Lamb; "Notes on the Solution of Statical Problems connected with Linkages and other Plane Mechanisms," by Prof. A. B. W. Kennedy; "On the Astatic Conditions of a Body acted on by given Forces," by Prof. Minchin; and "Progressive Waves," by Lord Rayleigh. Mr. H. McColl contributes a paper in two parts bearing on logic and probabilities, viz., "The Calculus of Equivalent Statements."

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 ensure the appearance even of communications containing interesting and novel facts.*]

Brorsen's Comet

I observed Brorsen's comet, about 8h. on March 29, through a whitish haze that extinguished the small stars near it. It appeared about the seventh magnitude, by estimation 3′ in diameter, its light very much condensed in the centre and approximately circular.

On April 4 I obtained the following places, although the moonlight much diminished its brilliancy:—

1874.		G.M.T. h. m. s.		App. R.A. h. m. s.		App. decl. ° ′ ″
April 4	...	8 29 59	...	2 56 53·7	...	+ 25 42 36
,,	...	8 38 31	...	2 56 55·3	...	+ 25 42 56

At the first observation the comet was compared with the star Arg. + 25°, No. 485; at the second with Arg. + 25°, No. 496 (Bonn Obs., vol. vi.). The observations admit of more accurate reduction.

The correction to the ephemeris of Herr Schulze (reproduced in Nature, vol. xix. p. 510) is—

In R.A. ... ... − 5·0 s. | In decl. ... ... − 31′ 20″

On both evenings when the equatorial was set to the position given in the ephemeris (with Strasser's correction, A.N. 2250) the comet was not in the field of a low power. The above correction to the declination may prevent loss of time in finding the comet.

G. L. Tupman

1, Vanbrugh Park, Blackheath, April 6

Madagascar Forms in Africa

A paragraph in a recent number of Nature (p. 470) mentions the discovery of a new species of *Ouvirandra* in Eastern Africa, the genus being hitherto supposed to be peculiar to Madagascar. The plant in question, which was collected by Dr. Hildebrandt, is, however, as has been pointed out by Dr. Trimen and myself (*Gardeners' Chronicle*, February 1, p. 149), not a species of *Ouvirandra*, being destitute of the fenestrated leaves, which is the only distinguishing character of that not very sound genus. It is, in fact, a well-known and widely-distributed African plant, *Aponogeton leptostachyus*, E. Mey. Dr. Hildebrandt, when lately in this country, fully assented to this identification.

A more novel fact in the same connection is the discovery by my colleague, Prof. Oliver, of a new monimiaceous plant amongst the collections of Gustav Mann in East Tropical Africa. The order itself, though represented in Tropical America and Asia, has hitherto been unknown in Africa, although the Mascarene Archipelago is well supplied with species, and one at least is known from the Comoro Islands, whence its remarkable fruit was sent to the Kew Museum by Dr. Kirk.

W. T. Thiselton Dyer

Transportation of Seeds

In Nature, vol. xvii. p. 390, which through the carelessness of my agent has only just reached my hands (together with the numbers for August, September, October, and part of November), I see Mr. Francis Darwin notices the penetration of certain grass seeds through the skin of sheep. It may interest him and your readers to know that I can corroborate this from what I have witnessed here and at the Cape of Good Hope.

In passing a butcher's shop in Noumea, lately, I was struck with the appearance of a fore-quarter of mutton. On a closer examination I found it so full of grass-seeds that it resembled a ham just unpacked from its bag of chaff. Many of the seeds had still their long thin tails drawn through the flesh like threads interlacing each other in every direction. On questioning the butcher, he said they rarely killed a sheep that was not more or less punctured.

All our sheep are imported for slaughter from Australia or Norfolk Island. This particular one came from the former place.

At the Cape of Good Hope I have skinned "spring-bucks," in which the shanks were pierced through and through with these "awms" and small thorns. My wonder has been how the animals could endure the pain of moving, but I suppose they do not suffer as we do.

E. L. Layard

British Consulate, Noumea, New Caledonia, February 1

Rayons de Crépuscule

What does Mr. Abbay call (vol. xviii. p. 540), the "low country" in Ceylon? If he means the sea-board generally, I

[1] We might take exception, perhaps, to his rendering of the title, which, we think, might have been more literally and better expressed by "On the Hitherto Unknown Diversities of Type in the Singing Organs," &c.

can assure him that, while magistrate at Point Pedro, five-and-twenty years ago, I used almost nightly to see "rayons de crépuscule" in the most glorious perfection for months together. Point Pedro is the extreme northern point of the island, with a splendid sea horizon. I shall never forget the beauty of the tints.

E. L. LAYARD

British Consulate, Noumea, New Caledonia, February 1

Salmon in Rivers of the Pacific Slope

IN a notice of the Report of the U.S. Commissioner of Fish and Fisheries, in NATURE, vol. xix. p. 430, the reviewer refers to the statement in a "memorandum respecting the American salmon and white fish recently introduced in New Zealand by Dr. James Hector," that "so far as yet observed, the adult fish all die after spawning and never return to the sea." The reviewer writes: "We shall be glad to have some authoritative statement with regard to the above fact, as without some explanation it seems too extraordinary for belief."

Dr. Hector in the above remark refers to the so-called "Californian Salmon" (*Salmo quinnat*) when in its native waters. There must be some exceptions to the rule as above stated, for Mr. Livingstone Stone, in his evidence in the same volume (p. 806), testifies that in the Columbia full-grown fish of this species are caught in considerable numbers, nearly exhausted, on the *back* of the drift-nets, in July and August, but it is nevertheless almost strictly true.

In the Fraser River, British Columbia, the general opinion is that the salmon never return to the sea except accidentally in a dying state. The Indians, who are generally well informed on such points, affirm this. The late J. K. Lord, in his "Naturalist in British Columbia," (vol. i. p. 40, *et seq.*), is very clear on the same point. It is, moreover, almost certain from the tumultuously rapid character of the Fraser, that the salmon hatched in its upper waters—in some instances 600 miles from the sea—never return there till mature and ready to spawn, and that this act is their last. They show no disposition to attempt to go back to the sea. I have seen them in great numbers in small streams tributary to the North Thompson, in August, spent, their silvery colour turned to a livid red (with the exception of the fins and tail, which are darker) but still heading persistently up stream, and continuing to do so, till from sheer weakness the current carried them away. In fording the brooks, the disturbance of the water causes those possessing sufficient vitality to scatter in all directions, but interrupts only for a moment their dogged struggle. At this season, in most years, dead salmon in great numbers are found floating down the stream, or stranded on the bars and banks of the river.

In Okanagan, Shuswap, and other lakes, there is a smaller fish, which may be a "land-locked" salmon, but of which I was not able to preserve specimens. The Indians say that it does not come from the sea, but lives in the deep waters of the lake, till in August it enters certain streams to spawn. Like the salmon it becomes, when spent, first blotched with pale red, and eventually altogether of that colour and without silvery lustre, the flesh at the same time losing its pink tint. It possesses the same instinct of struggling against the stream till it dies. I have seen them in brooks within a stone's throw of the lake, endeavouring with their remaining strength to keep themselves from being carried back into it.

Lord makes an exception of the "fall" or "dog-tooth" salmon (*S. lycaodon*), of which he supposes some go back to the sea, and return to the rivers in following years. It remains, however, an undoubted fact, that by far the greater part of the prodigious number of salmon entering the Fraser every year, perish. The fish appears to refuse food, and is not caught in the river by bait or fly, though frequently taken by trolling with fish or spoon-bait in the salt water.

It is much to be desired that a systematic investigation of the species of salmon frequenting the Fraser and other rivers of British Columbia should be made, embracing their habits and the course of their migrations. The subject is an interesting, but very intricate one.

GEORGE M. DAWSON

Geological Survey of Canada, Montreal, March 27

The Marsupials of Australia

THE peculiarities of the structure of the marsupials of Australia are so remarkable and their habits are so unlike those of the placentals of the Old World, that probably no apology is needed for venturing to lay before your readers a short account of one of these peculiarities possessed by certain genera, which I believe has escaped the observation of most naturalists, and may prove interesting to some of your subscribers.

The inferior maxillary or lower jaw-bone of almost all known mammals consists of two bones united together with more or less rigidity by a strong cartilage, which allows no play or independent movement whatever, and which practically firmly unites them into one bone.

The formation of the inferior maxillary of the Macropidæ, or kangaroos, is an exception, however, to this rule; instead of being united by a cartilage, the two rami of the lower jaw are jointed at their point of contact with a hinge somewhat resembling that upon which the two shells of a bivalve move, that is, upon corrugations which project from the two edges and fit accurately into one another.

These two rami extend a short distance beyond the point of contact, and into their terminations are fixed two long procumbent incisor teeth, the only two incisors possessed by this family in the lower jaw. Immediately in front of this joint, that is, at the root of the procumbent incisors, a circular muscle embraces the two rami of the jaw, the contraction of which has the effect of bringing the inner edges of the procumbent teeth together; upon its relaxation or the contraction of another set of muscles, placed probably at the extremities of the rami, where they hinge upon the facial bones, the incisors are separated the extreme distance allowed them by the ligaments around the joint. The action of separating the teeth is probably connected in some measure with the action of opening the jaws, as I not unfrequently found that when the mouth was widely opened, the teeth themselves became separated.

The muscular action of uniting the incisors may be said to be exemplified in the case of a pair of shears when the blades are closed by a grasp of the hand, and the force is applied between the fulcrum and the point of resistance.

In Prof. Owen's work upon the "Anatomy of the Vertebrates," the following passage appears, showing that he was aware of a certain looseness of connection of the two rami, but probably not aware of the completeness of the construction with its separate functions. After certain references to the wombat he says, "In other marsupials the rami of the lower jaw are less firmly united at the symphysis; they permit independent movements of the right and left incisors in the kangaroos, and in the opossum both the rami of the lower jaw and all the bones of the face are remarkable for the loose nature of their connections."

In the work upon "Odontography" by the same distinguished writer, various references are made to the lower incisors of the macropidæ, but his readers are in every instance led to believe that their trenchant margin is their outer edge, and I believe it has escaped his observation altogether, that the inner margin where the two teeth come in contact has the principal cutting edge.

Mr. G. R. Waterhouse was aware of the inner trenchant margin as in his "Natural History of the Mammalia," he refers to these incisors as having "cutting external and internal margins." Further on he says—"In *Macropus major* (and, perhaps, in some nearly allied species), the rami of the lower jaw are loosely attached at the chin, and at the apex they are free, and the animal has the power of slightly separating the lower incisors, so that their outer cutting edges are brought more closely in contact with the upper incisors than they otherwise would be." Were this, however, the only utility of the loose attachment at the symphysis, what function has the cutting inner margin to perform?

An examination of those incisors will disclose the following facts:—

If the jaw of one of the macropidæ is examined immediately after death, when the muscles are relaxed, it is found that the smallest pressure upon the base of the rami suffices to open the lower incisors to the extent of about one-fourth of an inch in larger specimens, and about one-eighth in the smaller Pademelons or Halmaturi. The inner edges of the procumbent teeth will then be seen to be sharp, but strongly supported by a considerable thickness of enamel immediately in rear of the edge, and when the teeth are united by the contraction of the muscles, they fit so perfectly throughout their whole length that they will grasp a hair at any point between the base and the apex. On the other hand, the outer margins of these teeth are blunt and somewhat rounded, and when the jaw is closed and at rest, instead of fitting on to the teeth of the upper jaw, as represented in diagrams in Owen's "Odontography," the two procumbent teeth rest upon a pad or projecting palate which rises from the inner base of the upper incisors, and whose surface is nearly upon the level of the edges of the upper teeth themselves; the lower incisors, therefore, are only brought into contact with the upper incisors by protruding the jaw forward.

I have, moreover, examined many specimens of the *Macropus major*, or kangaroo, and of varieties of the Halmaturus known as wallabies and pademelons, when they have been mortally wounded and under the influence of the spasmodic muscular contractions which occur at the point of death, and I have repeatedly found that they will alternately open the two incisors to their full extent, and unite them again with the energy which characterises all the muscular movements of an animal in its death-struggle.

If a small object, for instance the blade of a knife, is inserted between the teeth when fully extended, the animal will immediately grasp it with its incisors, which he will do without closing the jaw, showing that the movement is not absolutely dependent upon the action of closing the jaws, although, as I have said above, I believe it usually accompanies it.

The Phalangists or Australian opossums closely resemble the macropidæ in their dental formation, but they possess partially-developed canines in the upper jaw, whilst the latter have none in either jaw except in very early life; but although these opossums have their two procumbent incisors similarly situated, they probably do not possess the power of utilising them in the same manner; I have examined some specimens, but have failed so far to find more than the looseness of connection at the symphysis referred to by Prof. Owen.

In the genus which is represented by the Phascolarctos or native bear of Australia, which possesses the same lower incisors but distinct canines in the upper jaw, this arrangement is certainly wanting, as the rami of the lower jaw are firmly united.

This remarkable formation of the lower jaw of these kangaroos and wallabies is possibly an interesting instance of the retention of a construction, and of a set of muscles in a class of animals which have constantly required their aid to sustain life, which in other families of the animal kingdom have become rigid by ossification and cartilaginous formations, and by atrophy of the muscles in consequence of disuse.

The great plains and deserts over which these marsupials wander in search of food afford an exceedingly precarious supply of pasture in consequence of droughts and bushfires, which not unfrequently follow a superabundance of herbage. These animals, by means of their procumbent teeth which they make use of as shears, are thus enabled to cut off any green shoots or half-buried remains spared by a scorching sun, and obtain nourishment where any grass-feeding placental would certainly starve.

It is in consequence, I believe, of the power which is by this means given to these marsupials of eating scanty pasturage closer to the ground than any other animal, that in the great pastoral districts of New South Wales and Queensland it has been found that they are far more destructive of food than any stock that can be put upon the land, and in places where wallabies and pademelons are exceedingly numerous, it is noticeable that the native grasses in the particular localities which they frequent become completely destroyed, and that such places remain ungrassed until fresh seed is scattered over them by the winds.

HENRY WELD BLUNDELL

Gordon Downs, Queensland, December 5, 1878

Measuring the Velocity of Sound in Air

THE following simple way of arriving at the velocity of sound in air occurred to me lately:—Standing on a straight staircase between two blank walls (brick, and papered), which I find to be 32½ inches apart, I clap my hands. The effect from each clap is a brief musical sound, metallic in character, and of quite appreciable pitch. It arises, doubtless, from the disturbance travelling to and fro between the walls. The pitch I find to be, as nearly as possible, G sharp (in the fourth space). Now, the number of *complete* vibrations per second, corresponding to this note, seems to be about 205 (see Deschanel's "Natural Philosophy," p. 820). This implies that the disturbance, when I clapped my hands, made 410 excursions across the space per second. Consequently, $410 \times 32\frac{1}{2} = 13,325$ inches = 1,100 feet. This is exactly the number Deschanel gives as the velocity of sound in air at 50° (approximately our mean annual temperature).

M.

Snow Flakes

WHILST walking home on March 26, about one in the morning, snow began to fall very gently; but instead of the usual powdery or feathery appearance, each flake consisted of a distinct plate, in some cases perfect six-pointed crystals. I measured some of them, and the largest were as much as five-eighths of an inch across. On taking up a handful the appearance was still more remarkable; instead of the white opaque body one usually sees, the mass was pearly and semi-transparent, and so strongly resembling boracic acid, that I should have had some difficulty in distinguishing a handful of each substance by sight alone.

Near the lamps the effect was very beautiful, more especially when the road became covered, luminous points appearing in all directions, which scintillated like stars as one walked along, whilst many of the falling crystals reflected iridescent hues on nearing the ground.

When out of the town I ignited a piece of magnesium wire, and the effect was most brilliant.

It was a cold, dull night, barometer falling.

Burton-on-Trent FRANK E. LOTT

Rats and Water Casks

IN 1840, in a voyage from Sydney, *viâ* Madras, to London, about three weeks after leaving the latter, it was found that a number of water-butts, on their heads in the between-decks, were leaking. On examining them we ascertained that as many as ten or twelve butts had been perforated by rats; three or four were entirely empty from the leakage so caused, while the remainder contained ullages from about half to a few gallons. In every case the stave had been eaten through just above the chime hoop, and those which had been apparently most recently operated on had only been perforated so as to cause a slight weeping, while the empty ones showed an opening as large as an ordinary vent-peg hole. The rest of the voyage a tub placed in the square of the main hatchway was kept constantly supplied with water, besides one or more square tins of water on the main deck.

In the above voyage we stayed a week in Madras, and in loosing the foretop-gallant-sail on leaving, a rat and five or six young ones fell to the deck; and the sail was found to be so much eaten and full of holes, made to form and line the nest, that the sail had to be unbent and replaced.

Gurnet Bay, March 31 E. J. A'COURT SMITH

P.S.—The ship was the *Cornwall*, East Indiaman, Capt. Cow.

HEINRICH WILHELM DOVE

PROF. HEINRICH WILHELM DOVE was born at Liegnitz, Silesia, on October 6, 1803, and at the age of eighteen passed from the schools of that town to the Universities of Breslau and Berlin, where for the next three years he devoted himself assiduously to the study of mathematics and physics. In 1826 he took his degree of Doctor of Philosophy, his thesis on the occasion being an inquiry regarding barometric changes; and it is further significant of his future life-work that his first published memoir was a paper on certain meteorological inquiries relative to winds, these two subjects holding a first place in the great problem of weather-changes.

Dove began his public life as tutor and Professor at Königsberg, where he remained till 1829, being then invited to Berlin as supplementary Professor of Physics. His strikingly clear-sighted, bold, and original intellect turned instinctively to that intricate group of questions in the domain of physics which comprise the science of meteorology, and his success in these fields as an original explorer was so marked and rapid that he soon achieved for himself a seat in the Royal Academy of Sciences, and some time thereafter was raised to the distinguished position of the Chair of Physics in the University of Berlin.

Among the scientific and fashionable circles of Berlin he took first rank as a lecturer, the combined qualities of accurate science, fine imagination, lucidity of style, commanding presence, and the extent over which his utterances were heard, marking him out as the Arago and Brewster of Germany. Germany showered on him in profusion those honours and offices which it gracefully and gratefully bestows on learning and science; and perhaps there is no learned or scientific society of any note that has not the name of Dove enrolled among its honorary members. After a protracted and hopeless illness he died on Sunday last, April 6, in the seventy-sixth year of his age.

In the Royal Society's Catalogue of scientific papers, the lists under Dove specify 234 memoirs written between the years 1827-73. These show him to have been a successful worker and investigator in electricity, optics, crystallography, and in such practical matters as measures and the art of measuring, or the metric system of civilised nations. But it was to meteorological inquiries he devoted his full strength and all the powers of his mind, and, by his herculean but well-directed labours he has written his name in large imperishable characters on the records of science.

His fame rests on the successful inquiries he carried out with a view to the discovery of the laws regulating atmospheric phenomena which apparently are under no law whatever. The work he will be long best known by is his isothermals and isabnormals of temperature for the globe, in which work one cannot sufficiently admire the breadth of view which sustained and animated him as an explorer during the long toilsome years spent in its preparation. Equally characterised by breadth of view, and what really seemed a love for the drudgery of detail even to profuseness when such drudgery appeared necessary or desirable in attaining his object, are his various works on winds, the manner of their veering and their relations to atmospheric pressure, temperature, humidity, and rainfall, and the important bearings of the results on the climatologies of the globe; on storms and their connections with the general circulation of the atmosphere; the influence of the variations of temperature on the development of plants; and the cold weather of May—to which may be added the valuable system of meteorological observations he gradually organised for Germany, and the many full discussions of these which he published from year to year.

It is no small praise to pass on his work to say that those views he propounded, which subsequent researches are likely to modify materially, are those he arrived at by methods of investigation necessarily defective at the time. Thus, for instance, in inquiring into the law of storms, it was not in his power to work from isobaric charts, seeing that the errors of the barometer and their heights above the sea were known in but few cases. When we consider the condition in which he found man's knowledge of weather and the large accessions and developments it received from his hand, the breadth of his views on all matters connected with the science and the well-directed patience, rising into high genius, with which his meteorological researches were pursued, there can be only one opinion, that these give Dove claims, which no other meteorologist can compete with, to be styled "the Father of Meteorology."

THE INSTITUTION OF NAVAL ARCHITECTS

THE twentieth session of the Institution of Naval Architects has now been brought to a close. The meeting, with Lord Hampton in the chair, was held at the house of the Society of Arts, John Street, Adelphi, and was well attended throughout. One of the latest developments in ship-building is shown in the paper on "The Structural Arrangements and Proportions of H.M.S. *Iris*," by W. H. White, Assistant-Constructor of the Navy. The construction of the *Iris* marks a new era in the British Navy, being the first vessel built wholly of steel; she is an unarmoured dispatch vessel, specially designed for high speed and great coal endurance. Her principal dimensions are: length between perpendiculars, 300 feet, breadth, extreme, 46 feet, mean load draught, 19 feet 9 inches, displacement, 3,735 tons.

Special attention has been paid to resistance to torpedo attack by constructing the hold in twenty-one separate compartments and the double bottom and bunkers in forty; with the additional weight thus introduced, it is still found that there is a saving of weight in the hull by the use throughout of steel amounting to 12 per cent., or 175 tons. The engines take 28 per cent of the displacement, and 20 per cent. is available for coal, which is estimated to be sufficient for steaming 7,000 knots at a speed of 10 knots per hour. The speed attained by the *Iris* on the measured mile was 18·6 knots, with an expenditure of 2·3 indicated horse-power per ton of displacement as compared with 14 indicated horse-power, required by a torpedo vessel.

In striking contrast with the *Iris* we have the monster proposed by Rear-Admiral J. H. Selwyn in his paper "On the most Powerful Ironclad." The author of the paper has long advocated some modification of the circular ironclad first proposed by Mr. Elder some years ago, and carried out with some alterations by Admiral Popoff. The vessel here proposed is 370 feet in length 220 feet in breadth, with a draught forward of 18 feet and aft 13 feet. Her armament is to consist of twenty 80-ton guns, or eight 100-ton and eight 80-ton; these are to be mounted in two gun-pits on the Moncrieff hydro-pneumatic principle. The guns are carried on a turn-table of the full size of each gun-pit, the floors of which are composed of steel bars set on edge to provide for ventilation, but to keep out shell fragments; the breast-work round each will consist of 30 inches of armour-plating. The guns would be raised by hydraulic power to fire over the breast-work, recoiling automatically under cover for re-loading. The vessel would be protected with a belt of 30-inch armour round the water-line, and a thickness of 25 feet of coals stowed inside it. There would be two Perkins hydraulic engines of 21,000 horse-power for propulsion and steering, and these would be at once available for keeping the vessel afloat in case of a leak. The author estimates that if a hole 10 feet square were made by a torpedo, the engines would be able to keep the water under, while danger of sinking by such damage is much lessened, if the engines are partially disabled, by the large number of water-tight compartments. It cannot be denied that the Russian Popoffkas have been far from successful, especially in facility of steerage, which was one of the main advantages claimed for them, but it can only be determined by an actual experiment whether our naval authorities can overcome the difficulties in speed and steering which have baffled the Russian Admiralty. Even if a vessel as here proposed could not be made sea-going, or to attain a 16-knots speed as claimed, she would at least be more valuable as a harbour defence than a Spithead or Plymouth breakwater fort, and could be adapted to some sites at a less cost in proportion to the weight of armament.

"Armour for ships" by Mr. Barnaby, C.B, Director of Naval Construction, consists of a general review of the progress of armour-plating from its introduction in 1854 down to the present time. The description of the steel turret-plates manufactured by Messrs. Schneider at Creuzot, 32 inches thick, and weighing 65 tons, is not without significance in the present state of depression in the iron trade of this country, but some consolation is to be obtained from the account given of the steel-faced plates of Messrs. Brown and Cammell which shows that some progress is still being made nearer home. The paper by Admiral Sir R. Spencer Robinson, K.C.B., F.R.S., gives an exhaustive statement of the experiments that have been made on various targets at Shoeburyness, representing the armour of different ships. A table is given showing the displacement, thickness of armour, and proportion of the former to the latter in ships of different types; this ratio varies from 6·38 in the *Warrior*, 4·00 in the *Alexandra*, to 2·95 in the *Dreadnought*, and 2·50 in the *Glatton;* thus the last may be considered the most heavily-armoured vessel in proportion to size in the navy. The penetration of shot of different diameters and weights with various velocities is given, and the experiments show that it is proportional to the energy of the shot on impact whether due more to velocity or weight, and inversely proportional to diameter of shot; also that the resistance of solid plates is proportional to the square of their thickness. The resistance of composite targets is treated at some length, and a comparison drawn between the various forms adopted in existing ships and the Millwall shield designed by Mr. Hughes, in which the latter is shown to be preferable; but the questions of steel and steel-faced armour which are now attracting the attention of artillerists are not gone into, and are only referred to with the evident feeling that the end of the battle between guns and armour has not yet come.

The paper "On the Resistance given to Screw-Ships by the Action of the Screw-Propeller, and how to Remedy it," by Robert Griffiths, points out an important difficulty in screw-propulsion which has only recently been recognised. A screw-propeller obtains the resistance to drive the ship forward by accelerating the velocity of the currents of water flowing past the stern of the vessel; as in different parts of the screw's disk these currents are encountered at different velocities, the resistance to a blade is not uniform throughout a revolution. In experiments made at Devonport by towing a screw-pinnace, it was found that the water flowed through the lower half of the screw disk nearly at the speed at which the boat was towed, but in the upper half it was so dragged by the boat as to flow past the screw at only half that speed. In dynamometer diagrams, taken with H.M.S. *Rattler*, it was shown that the thrust of the screw varied from 2·9 to 4·1 tons in each revolution. The increase in the resistance of the ship, due to the working of the screw above that due to the ship herself when towed at the same speed, and which Mr. Froude has shown to be 40 or 50 per cent., is considerably greater when the upper currents are more accelerated than it would be if the acceleration were uniformly given to the whole column of water passed through by the screw disk. The author proposes a screw-propeller so constructed that the blades always meet with equal resistance. The blades are so made that more than half their surface is aft of the centre line, so that the pressure on their surface tends to lessen the pitch; they are also made movable in the boss, but so connected that by decreasing the pitch of one, that of the other is increased; when, therefore, one blade meets with more resistance than the other, the increased pressure causes it to turn and throw some of the work on the other.

In his paper on naval guns, Mr. C. W. Merrifield vigorously attacks the Woolwich type of gun, pointing out the disadvantages and absolute futility of the increasing twist in rifling at present adopted. It is now four or five years since this was first done by Prof. Osborne Reynolds, and, aided by the *Thunderer* explosion, it is to be hoped that the time is drawing near when the subject will receive the consideration of the War Department. The author also lays great stress on the advantages of breech-loaders over muzzle-loaders, regarding the latter now, with its complication of gear and fittings, as inferior to the former, even in the simplicity always claimed for it.

Amongst other papers read at the meeting are the following:—"On Sir William Thomson's Navigational Sounding Machine," by P. M. Swan, in which the accuracy of this now well-known apparatus is amply testified by a large number of observations; and a paper by Mr. J. Scott Russell, F.R.S., "On the true Nature of the Wave of Translation, and the Part it plays in Removing the Water out of the Way of a Ship with least Resistance."

OUR ASTRONOMICAL COLUMN

NOTE ON 72 OPHIUCHI (O. Σ. 342).—The publication of the entire series of observations of this suspected double star, made at Pulkowa to 1876, does not lessen the difficulty of arriving at a definite conclusion as to its duplicity or otherwise. On November 1, 1841, it was noted double magnitudes 4 and 7 on Struve's scale, and, no doubt attached to the observation; on May 14, 1842, it appeared single, but at the epoch 1842·72 it was again double, the measures giving for position, 156°·6, and distance, 1″·3. Subsequent observations gave the following results:—

1844·85	...	Single, or with only a suspicion of elongation at 63°; images excellent.
1845·62	...	With very good images; no companion seen.
1846·49	...	Single, or perhaps slightly wedged at 87°.
1847·50	...	Pos. 162°·4, dist. 1″·61, but there was a doubt if the object observed was not an optical illusion.
1847·70	...	Pos. 168°·1, dist. 1″·6. M. Struve says: "I feel sure of the duplicity, but the images are not very good."
1848·79 1850·50 1851·51	...	Single.
1851·67	...	Pos. 166°·3, dist. 1″·49. After the observation a note was added—"This is only an optical deception."
1852·63	...	Single; under excellent atmospheric conditions.

This last observation appearing decisive, M. Struve considered that 72 Ophiuchi should be omitted from the list of double-stars, and in the following years only examined it once (1859·66), when it was again single under very favourable conditions. But in 1876 he found reason to modify his view: at 1876·67 the satellite was seen very distinctly, with position 156°·0, distance 1″·60; a fortnight later there were only very slight impressions of a satellite, and M. Struve remarked that the principal star of 70 Ophiuchi presented an analogous phenomenon, though less distinctly. Hence arose the suspicion that the said impressions were caused by accidental conditions of the air and the instrument. Nevertheless, on considering the preceding observations and the fact of their being made without the least recollection of anterior ones, M. Struve thinks their approximate agreement cannot be attributed to chance, and that we are necessarily led to infer that the star is really double, but the companion undergoes considerable and rapid variation of brightness. It is worthy of note that only three weeks before the Pulkowa observation of 1859, when the star was pronounced single, Secchi had recorded of it: "Certainly double, and well separated," his measures giving the position 3°·75, distance 0″·61.

THE VARIABLE STAR χ CYGNI.—According to the later observations of Dr. Julius Schmidt at Athens, it is probable that the next maximum may occur on or about April 25, and the next minimum about December 14. At the last observed maximum on March 14, 1878, the star was hardly a fifth magnitude, which is about the mean brightness in that phase, the extreme limits of variation being two magnitudes or 4m.—6m. according to Prof. Schönfeld; at minimum it descends to 13m. No formula has yet been deduced which will represent satisfactorily the totality of the observations, commencing with those of Kirch the discoverer in 1686; considerable irregularities following no law so far discovered occasionally presenting themselves. This is particularly evident if we compare Argelander's last formula in vol. vii. of the Bonn observations with the observed times of maxima during the last fifteen years. The place of the true χ Cygni of Bayer, which is the variable, is, for 1880·0, in R.A. 19h. 45m. 57·3s., N.P.D. 57° 23′ 18″; it therefore follows the star to which Flamsteed attached this letter, 4m. 4s., and is south of it 50′·6; Flamsteed's star ought to be called by his number, 17 Cygni. At the times when he was looking for Bayer's χ, as Argelander has remarked, the variable would be near a minimum; hence his observing the nearest star of similar brightness.

THE MINOR PLANETS IN 1879.—Advanced sheets of the *Berliner astronomisches Jahrbuch* for 1881, containing places of the small planets during the present year have been circulated amongst observers, the ephemerides for the planets coming into opposition early in the year, some time since. There are positions of the first 187 members of this group, with the exception of Nos. 99 and 155, for which sufficient data are not available. Only two out of the number approach the earth at opposition, within her mean distance from the sun: *Isis*, on June 20, is distant 0·995, with a south declination of 25°, and *Hertha*, on September 12, 0·988, just upon the equator. No. 154 travels as far south as 50½° about July 14.

BRORSEN'S COMET.—The observations of this comet made at Arcetri and Kremsmunster from March 10 to 19 with Dr. Schulze's other elements, fix the time of perihelion passage to about March 30·5716 G.M.T., which is nearly twelve hours later than that assigned by calculation. The following ephemeris is founded upon this corrected epoch for arrival at perihelion:—

For 12h. Greenwich M.T.

1879.	Right Ascension. h. m. s.	Declination, North. ° ′	Log. distance from Earth.	Log. distance from Sun.
April 14	3 39 10	38 44·7	9·9202	9·8199
,, 15	3 43 59	40 3·9		
,, 16	3 49 0	41 23·0	9·9092	9·8317
,, 17	3 54 12	42 42·2		
,, 18	3 59 37	44 1·2	9·8986	9·8442
,, 19	4 5 18	45 20·0		
,, 20	4 11 16	46 38·4	9·8887	9·8571
,, 21	4 17 32	47 56·3		
,, 22	4 24 9	49 13·6	9·8794	9·8703
,, 23	4 31 8	50 30·0		
,, 24	4 38 33	51 45·4	9·8709	9·8836
,, 25	4 46 25	52 59·5		
,, 26	4 54 46	54 12·1	9·8633	9·8969
,, 27	5 3 39	55 22·9		
,, 28	5 13 7	56 31·6	9·8565	9·9103
,, 29	5 23 12	57 38·0		
,, 30	5 33 57	58 41·7	9·8507	9·9235

EDISON'S LAMP

A COMMUNICATION in yesterday's *Daily News*, from a New York correspondent of that paper, gives a glowing, and to all appearance justifiably so, account of Mr. Edison's success in attaining a form of electric lighting that seems to be in all respects much superior to anything hitherto produced. The first impression made on the correspondent was the mild effect of the light on the eyes, its steadiness, and the absence of that ghastly hue which seems to be an invariable accompaniment of the carbon. This new form of light has only been attained after many disappointments on the part of Mr. Edison, who, however, has all along been confident of success.

During the past two months the progress towards its present perfection has been very rapid. Chiefly contributing to this result has been the discovery of a new alloy, the fusing-point of which is much higher than either platinum or iridium, in fact, than any known metal. This discovery is spoken of by some of Mr. Edison's chief *employés* as the greatest achievement of his life. This alloy also reduces the cost of the valuable metals used in each lamp to such a point as to do away entirely with Prof. Tyndall's criticism. It is said to possess properties heretofore unknown, or at least undefined by scientific men. Not only has it cheapened the cost, but the union of the metals has increased the illuminating power to such a degree that six lights are now obtained per horse power where only four were possible with the pure platinum coil. Six lights per horse-power is the number authoritatively stated, but Mr. Edison's chief assistant does not hesitate to predict that eleven lights will eventually be obtained for each horse-power. This is not expected from the Gramme machine, however, which is now used; but is hoped for after the completion of the new generator, which a dozen of the most skilled workmen at Menlo Park are now engaged in constructing.

The lamp itself takes many forms. In some instances it is attached to the wall, like a gas bracket, and in many others it hangs from the ceiling and takes the external form of a glass globe, capped by brass or nickel attachments. There is none of the hissing, sputtering, and flickering observable in the carbon lamps. The lamp which attracts most attention is, in appearance, a St. Germain student lamp, without the reservoir for the oil. It stands in the middle of a small table, and two fine covered copper wires alone connect it with the main conducting cables from the Gramme machine. In this the *Daily News* correspondent tells us, are embodied all the latest improvements. He also tells us that there cannot possibly be any mistake, as Mr. Edison has taken crucial precautions in all directions. There is nothing in the lamp itself that gives any idea of its construction. The cunning device for rendering the flame steady is in reality the idea of the quadruplex telegraph applied to heat instead of electricity. Now that the new alloy has been discovered, its twofold purpose of preventing fusion and steadying the light is no longer served. The expansion of the tiny key, or switch, breaks the current for the fraction of a second, and permits the actual, though imperceptible, cooling of the incandescent coil. This connection is made and broken many times during each second, so that to human eyes the light is constant as the sun. The movement of a finger and thumb converts the glowing meteor before us into a night lamp for a sick-room. Again, it is seen at one-candle power, then at two, and so on. It is as manageable as a tallow dip, and much more satisfactory. It will not go out of itself, and needs no care. The little coil of wire is hermetically sealed in the glass chamber. It is not in a vacuum, but the chamber is filled with air. There is a sensitive spot on the metal cap in which the glass tube sits, and the expansion of the air manipulates the switch. The heat of the metal itself, therefore, is no longer relied on. The inventor explains that after all manner of severe tests this has been found the easiest and the least easily deranged manner of controlling the light. The difficulty of making thin plates of metal of equal density and weight rendered the previous method impracticable for small lights, although it will probably be the best form in which to secure the desired result where the lamps are to show lights of great intensity.

As there seems no reason to distrust the evidence of the *Daily News* correspondent, it may be accepted that Mr. Edison has succeeded in going a long way to solve some of the difficulties connected with the practical adoption of electric lighting. It is stated that in a few months the Edison Company will be prepared to supply the light to such private consumers as may desire it at at least one-third or one-fourth the cost of gas.

EXPERIMENTAL RESEARCHES ON THE REPULSION RESULTING FROM RADIATION[1]

II.

HAVING completed the experimental investigation of the amount of repulsion produced by radiation on disks of various kinds, and coated with different substances, I turned my attention to the amount of repulsion produced when polarised light is allowed to fall on a plate of tourmaline suspended in vacuo in a torsion balance. It was originally thought that a slice of tourmaline, being black to a ray of light polarised in one plane, and white to a ray polarised in the other plane, would be repelled when the incident light was quenched by it, and not affected when the incident light passed through it. Experiments, however, prove that this action does not exist in any

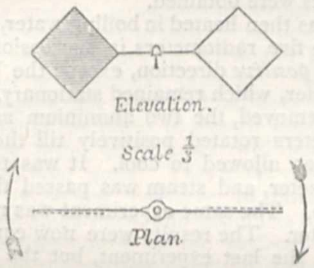

FIG. 4.

appreciable degree, the repulsion resulting from radiation being almost entirely a surface action, whilst the action of a tourmaline on a ray of polarised light is one in which thickness is necessary.

I next examined the effect of shape in influencing the amount and direction of repulsion. These experiments were for the most part tried with the apparatus shown in Fig. 3 (p. 513, part I.). Through the open top access can readily be obtained, and disks, plates, &c., can be quickly tested by being fixed to the extremities of a pair of aluminium arms, with a glass cap in the centre, rotating on the needle-point. Plates, 12 millims. square, cut from thin aluminium foil, were mounted diamond-wise on arms, and supported on the needle-point inside the bulb. The plates were lampblacked on sides facing

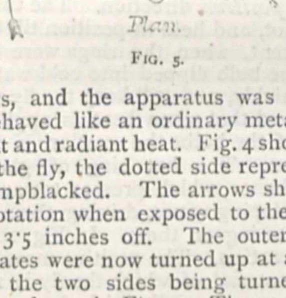

FIG. 5.

opposite ways, and the apparatus was well exhausted. The vanes behaved like an ordinary metal radiometer in respect to light and radiant heat. Fig. 4 shows the elevation and plan of the fly, the dotted side representing the one which was lampblacked. The arrows show the direction of positive rotation when exposed to the light of a standard candle 3·5 inches off. The outer corners of the aluminium plates were now turned up at an angle of 45°, 4 millims. of the two sides being turned up, leaving 8 millims. flat, as shown in Fig. 5. They were lampblacked on the inside, as shown in the figure by dots. A lighted candle 3·5 inches off caused very slow and feeble positive rotation. On shading the light from the black side, the bright side was repelled, causing positive rotation; and on shading the light from the bright side the black was repelled, causing negative rotation.[1] The positive repulsion was, however, rather stronger than the negative repulsion, so that, when both sides were illuminated, the force was only that due to the difference of these repulsions.

A hot glass shade is a convenient means of heating the bulb, by immersing it in a hot-air bath, without the liability of introducing action of rays other than those emitted by hot glass. On inverting a hot glass shade over the bulb in the above experiment, negative rotation was produced which changed to positive on cooling. Both these rotations were stronger than that given by the candle. The experiment was varied (1) by 6 millims. of the sides being turned up instead of 4; (2) by folding the plates across the vertical diagonal and then across their horizontal diagonal; (3) by attaching flat

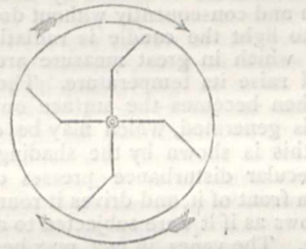

FIG. 6.

plates to the arms at an angle of 45°, blacking them on the insides away from the bulb, and repeating the experiment with plates blacked on the outsides. The results obtained show that when flat plates are taken blacked on alternate sides, the rotation is normal or positive, *i.e.*, the black side is repelled. When the outer corners of each plate is turned up so as to keep the blacked surface on the concave side, the positive rotation is either diminished, stopped, or converted into negative rotation, according to the amount of surface of the plate which has been turned up. The favourable presentation of the surface of the vanes to the inside of the bulb has more influence on the movement than has the colour of the surface. Radiometers constructed with silver flake vanes set at an angle

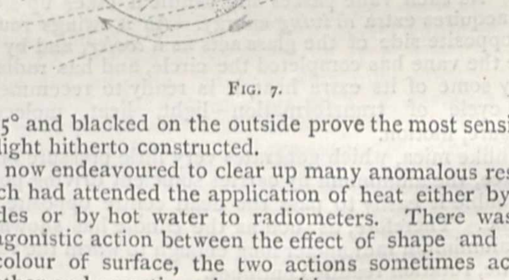

FIG. 7.

of 45° and blacked on the outside prove the most sensitive for light hitherto constructed.

I now endeavoured to clear up many anomalous results which had attended the application of heat either by hot shades or by hot water to radiometers. There was an antagonistic action between the effect of shape and that of colour of surface, the two actions sometimes acting together and sometimes in opposition.

Five radiometers were made exactly alike in size of bulb, shape of vanes, and degree of exhaustion, only differing in the material of which the vanes were composed. No. 1 was made of mica, 0·003 inch in thickness; No. 2, of mica, 0·0005 inch in thickness; No. 3, of pith,

[1] Continued from p. 514.

[1] I call the rotation *positive* when the black or driving side is repelled, and *negative* when the side which under ordinary circumstances would be the driving side, moves towards the light.

0·05 inch in thickness; No. 4, of aluminium, 0·002 inch in thickness. These four radiometers were plain on each side, no lampblack being applied. Their appearance is shown in Fig. 6. No. 5 was made of aluminium, identical with No. 4, but the vanes were lampblacked on each side instead of being bright. Had the vanes pointed radially there could have been no tendency for any one of the flies to move either way, but being inclined, the normal movement, on exposure to radiation, should be in the direction of the arrows—a direction which I called the *positive* direction.

In Fig. 7 the candle is represented shining on the bulb of the mica-vaned radiometer. The rays of light pass through the first wall without action. They then meet the mica, and that also being transparent, the rays pass through it likewise, and then escape through the opposite side of the bulb as is shown by dotted lines, without absorption and consequently without doing work. But in addition to light the candle is radiating ultra-red dark heat-rays, which in great measure are arrested by the glass, and raise its temperature. The inner surface of the bulb then becomes the surface on which molecular pressure is generated, which may be called the *driving* surface; this is shown by the shading next the candle. This molecular disturbance presses on the mica-vane which is in front of it, and drives it round in the direction of the arrows as if it were subjected to a bombardment of small shot. The vanes, in fact, may be said to be blown round by what may be likened to a wind, which however is not *molar* but *molecular*, inasmuch as there is no wind

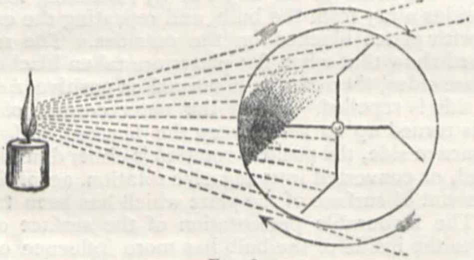

FIG. 8.

in the sense of an actual transference of gas from one part of the bulb to the other.

In Fig. 8 I have endeavoured to represent part of the action which takes place when the candle shines on the aluminium radiometer. The light passing through the bulb falls on the aluminium plate, and raising its temperature, causes pressure to be exerted on all sides. The molecules rebounding from the face next the glass, cause increased molecular pressure on that side, and produce movement in the direction of the arrows, or positive rotation. As each vane passes the candle it takes up heat, and acquires extra *driving* energy. As it swings round, the opposite side of the glass acts as a *cooler*, and by the time the vane has completed the circle, and has radiated away some of its extra heat, it is ready to recommence the cycle of transformation—light, heat, molecular pressure, motion.

Unlike mica, which generates very little pressure on its surface, the aluminium fly carries sufficient driving power to enable it easily to pass the dead centre opposite the candle. Therefore, as soon as the candle has shown on the aluminium radiometer long enough to warm the vanes a little, rotation readily continues.

The action of the pith radiometer is similar to the aluminium, except that the dissipation of pressure from the back surface of the pith will be almost *nil*. The pith, moreover, being sensitive to the heat-rays, and being a non-conductor, moves quicker than the aluminium, which requires time to get warm throughout.

The agreement between theory and observation, so far, seemed exact. I now tried numerous experiments with dark heat applied in various ways to these five radiometers. The results I obtained led me to think that the kind of dark heat might vary in refrangibility according to its source, and that the rays from hot water, hot glass, and hot metal, might affect the materials composing the vanes in a different manner, and being absorbed by one body and transmitted by another, might cause the positive or negative rotation which I obtained. I immersed the five radiometers in boiling water, and after cooling again immersed them in water only a few degrees above the temperature of the room; the results were similar to those I had previously obtained with water of 70° C. The radiometers were covered successively with hot shades of English, French, and German glass of different thicknesses, and at different degrees of temperature. The bulbs were also heated with a gas or spirit flame, but no uniform results were obtained.

A funnel was then heated in boiling water, and allowed to rest on the five radiometers in succession. They all moved in the *positive* direction, except the bright aluminium radiometer, which remained stationary. When the funnel was removed, the two aluminium and the thick mica radiometers rotated positively till they were cold. The funnel was allowed to cool. It was then inverted over a radiometer, and steam was passed through for a second or two. The same experiment was repeated with each radiometer. The results were now equally uniform with those of the last experiment, but the rotation was

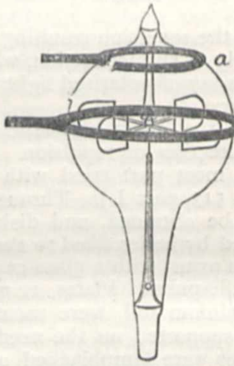

FIG. 9.

negative, the bright aluminium fly moving the best o all, and the pith fly the least.

I repeated the experiment with a thick brass ring, the internal diameter of which was about half that of the bulb (Fig. 9, *a*) and then with another brass ring a little larger in diameter than the bulb, *b*, Fig. 9. These rings were each heated to about 400°. With the first the rotation was *negative*, while in the second all the flies revolved in the *positive* direction. The two brass rings were made red hot, and held in position till the flies were in rapid movement, when the rings were removed and the hot part of the bulb dipped into cold water, so as to chill the glass quickly, and still keep the fly warm. These experiments proved that when heat is applied round an equatorial ring of the bulbs the rotation is always in the positive direction. The hot ring of glass generates molecular disturbance, which presses towards the centre and strikes the sloping vanes, driving them round as if the wind were blowing on them. In Fig. 10 I have tried to represent this action. The positive movement is independent of the material of which the fly is made, and is only slightly increased or diminished according to the conducting power of the fly for heat. The lighter the weight of the fly to be driven round, the easier it moves, and the heavier the fly the longer it keeps in motion after it is once started.

When heat is applied to either pole of the bulb *negative* rotation takes place. The molecular pressure proceeding from a hot pole of the bulb will strike the *inner* surface of the sloping vanes. and driving them before it, will cause a rotation which appears *negative* to an observer, although it is really *positive* to the direction of pressure. Fig. 11 sufficiently illustrates this mode of action. The heat is supposed to be applied near the centre, and the molecular pressure, radiating on all sides, presses the vanes chiefly on the inner surfaces. The anomalous results obtained when the radiometers were heated with hot glass shades or hot water are thus accounted for. Polar heating gives *negative*, and equatorial *positive*, rotation, and when both are applied together by immersion in hot water, the direction of motion is governed by the stronger of these two forces.

In my description of Fig. 7 (p. 534) I showed that the glass heated by the ultra-red rays became hot, and acted on the driving surface, generating molecular pressure, and causing the sloping vanes to turn in the positive direction. At the same time the vanes get warm and become themselves sources of molecular pressure. The amount of molecular pressure thus generated depends on the capacity of the material of the vanes to absorb heat. Thin mica will hold very little, thick mica will hold more, and aluminium will hold most. This extra capacity for heat causes more molecular pressure to proceed from the aluminium and thick mica, and generates a proportionate amount of driving power on the surfaces of the vanes, turning them in the positive direction, and supplementing the action of the equatorial ring of hot glass.

The next subject of investigation was the action of radiation on cones, cylinders, and cup-shaped vanes. A pair of

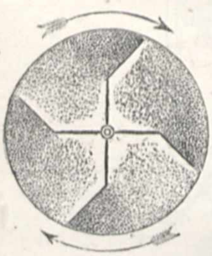

Fig. 10.

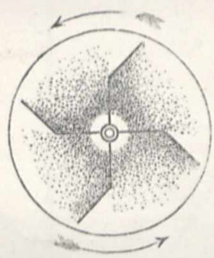

Fig. 11.

thin aluminium disks, cut half across the diameter, were bent into cones and mounted on two arms as a radiometer, the cones facing opposite ways. Several experiments were tried and repeated with cones of different material. The movement which appeared most anomalous was the attraction observed when a candle was allowed to shine on the hollow side of a cone or cup-shaped radiometer, the light being screened off the retreating side. Further experiments, however, showed that the effect of bending the plates, or of making cones of them, is to produce a more favourable presentation to the inner surface of the glass bulb. Radiation falls from the candle on the aluminium; some is reflected and lost, but a portion is absorbed, to be converted into thermometric heat or heat of temperature. Aluminium being a good conductor of heat, and the thickness of metal being insignificant, it becomes equally warm throughout, and a layer of molecular disturbance is formed on each surface of the metal. At a low exhaustion the thickness of this layer is not sufficient to reach from the metal cone to the side of the glass bulb; as the exhaustion increases, this layer extends further from the generating surface, until at a sufficiently high exhaustion the space between the side of the glass bulb and the adjacent portion of the metallic cone is bridged over, and pressure is exerted between the two surfaces. Fig. 12 shows how this pressure will act. The direction of pressure is indicated by dotted lines issuing from the metal cone. The more favourable presentation offered by the cone causes the pressure to be greatest between the glass bulb and the outside of the cone; the pressure from the inside of the cone and from the outside, away from the side of the glass, is dissipated without acting, but the pressure between the glass bulb and the side of the cone nearest to it is active; the cones, therefore, are pressed round in the direction of the arrows, and the motion has the appearance of *attraction*.

Cones being inconvenient in shape, I employed portions of cylinders wherewith to shape the vanes, and I ultimately found that cups were more easily affected by radiation than portions of cylinders, whilst they are more easily fashioned. I found that a four-armed cup-shaped aluminium radiometer, the cups being bright and 10 millims. in diameter, and the radius of the curvature being 6 millims., rotates in the light as well as a flat vaned instrument. I sealed one of these instruments on to the mercury pump. During exhaustion accurate observations were taken of the number of revolutions per minute caused by one or more standard candles 3 inches from the centre of the bulb. I also took observations of pressure, and the exhaustion was carried to a very high point. Fig. 13 shows the curve plotted from these observations, taking the rarefaction of the air in millionths of an atmosphere as abscissæ, and the number of revolutions a minute as ordinates. The curve traced through the dots representing observations illustrates the gradual increase of sensitiveness up to a certain point of rarefaction, and the sudden drop after that point is reached.

To still further investigate the action of dark heat on the vanes, I contrived an apparatus to which I could apply a very intense source of heat always ready in the

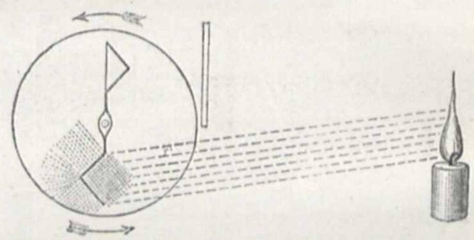

Fig. 12.

same place, the heat not having to pass through glass, and being completely under control as to intensity and time of action. The instrument with which I performed the great number of these experiments is shown in Fig. 14. The cylinder is sealed at the top so as to permit of the highest possible exhaustion. It is drawn off narrow at the end, and a stem is sealed in to hold a needle-point. To the narrow end a fine tube is attached to connect the apparatus to the mercury-pump. Round the needle is placed a ring of fine platinum wire, *a a*, the ends of which are joined to thicker platinum wires passing through the glass. The fly consists of four square vanes of clear mica, *b b*, inclined at an angle of 45° to the horizontal plane and supported on light aluminium arms. Above the vanes is a flat disk of clear mica, *c c*, having a glass cap in its centre, and easily rotating on a needle-point. The vanes and the mica disk are supported independently of each other on separate needle points, which are held in glass rods, *d*, *d*, *d*. A current of electricity from two Grove's cells, turned on or off by a contact key, gives the power of making the wire ring, *a a*, red hot when desired.

The normal or positive movement of the disk is in the opposite direction to that of the vanes; thus, if the positive movement of the vanes is in the direction of the hands of a watch, the positive movement of the disk is in the opposite direction. With the apparatus full of air at the ordinary pressure (bar. = 761 millims.) the direction of rotation, both of the vanes and disk, is *positive* when the platinum wire is ignited. The speed of the vanes is 13·3 revolutions a minute, and that of the disk 1 a minute

At a pressure of 80 millims. the disk does not rotate. The vanes rotate *positively* but slowly.

At 19 millims. no movement whatever takes place. The disk and vanes are as still when the wire is heated as when it is cold.

At 14 millims. the disk remains stationary. The vanes move slowly in the *negative* direction.

At 1 millim. the disk rotates in the *positive* direction slowly, whilst the vanes rotate *negatively* rather fast; the disk commences to rotate in the same direction as the vanes at a speed of three revolutions a minute.

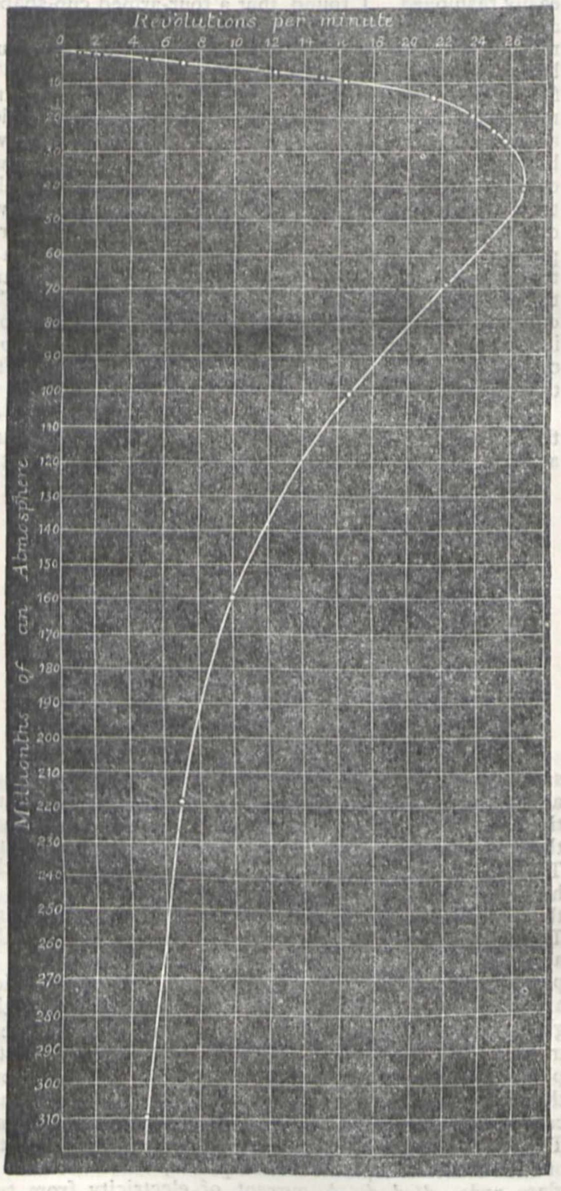

Fig. 13.

(At low exhaustions I speak of millimetres of pressure, but at high exhaustions I prefer to count in millionths of an atmosphere.)

At a pressure of 706 millionths of an atmosphere the direction keeps the same as at 1 millim. in each case, but the disk makes ten revolutions and the vanes forty revolutions a minute.

At 294 millionths, the speed of the disk and vanes is exactly alike, both rotating together in the same direction. Up to this pressure and at some distance beyond, the vanes have been gradually diminishing whilst the disk has been increasing in speed. At a pressure of 141 millionths the disk rotates rapidly, *positively*, but the vanes do not rotate at all. At a little higher exhaustion than the last, viz., at 129 millionths, a great change is observed. The vanes which were still now rotate in the *positive* direction at a speed of 100 revolutions a minute, whilst the disk rotates as before, but with a little diminished velocity. I have previously shown, in a paper to the Royal Society, that the viscosity of air at a rarefaction of 129 millionths of an atmosphere is only a little less than its viscosity at the normal density, and hence it is certain that the vanes at a speed of 100 revolutions a minute exerts a considerable drag upon the disk when it rotates in the opposite direction.

As the rarefaction increases above this point, the speed of both the disk and vanes increases till those of the latter exceed 600 revolutions a minute.

To carry these experiments to a much higher exhaustion it was necessary to modify the apparatus. The complex apparatus I now employed is shown at Fig. 15. Only the upper part of the pump *a b* is shown. It has five fall tubes and is fitted with a small radiometer, *c*, and a McLeod measuring apparatus, *d e*, to enable the degree of exhaustion in the apparatus to be ascertained. The phosphoric anhydride, for absorbing aqueous vapour, is contained in the horizontal tube *f*. In order as far as possible to prevent the passage of mercury vapour, three long narrow tubes *g g* are introduced between the pump and the apparatus to be exhausted; the one nearest the pump is filled with precipitated sulphur, the centre tube contains metallic copper reduced from its oxide, and the third tube phosphoric anhydride. At *h* is a vacuum-tube containing aluminium wires, and having a capillary bore for examining the spectra of the residual gas. An induction coil and battery are connected with the tube by wires. From the tube *h* two tubes branch off, one of them, *i*, leads to the "viscosity" apparatus contained in the case *k*, and the other, *j*, goes to the apparatus to be exhausted.

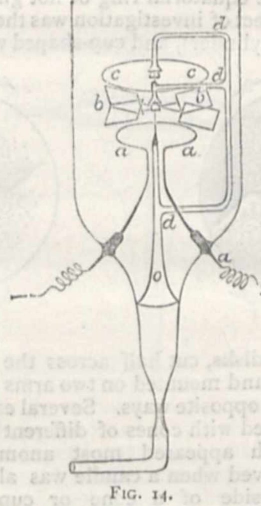

Fig. 14.

The apparatus *s*, containing the rotating disk and vanes, is sealed to the tube *j*. The platinum ring is ignited by the battery *t*. On the top of the ring rests a disk of mica, H, lampblacked on the upper surface; this cuts off direct radiation from the hot ring, and diffuses the heat somewhat over the surface of the black mica. Instead, therefore, of the molecular pressure starting from

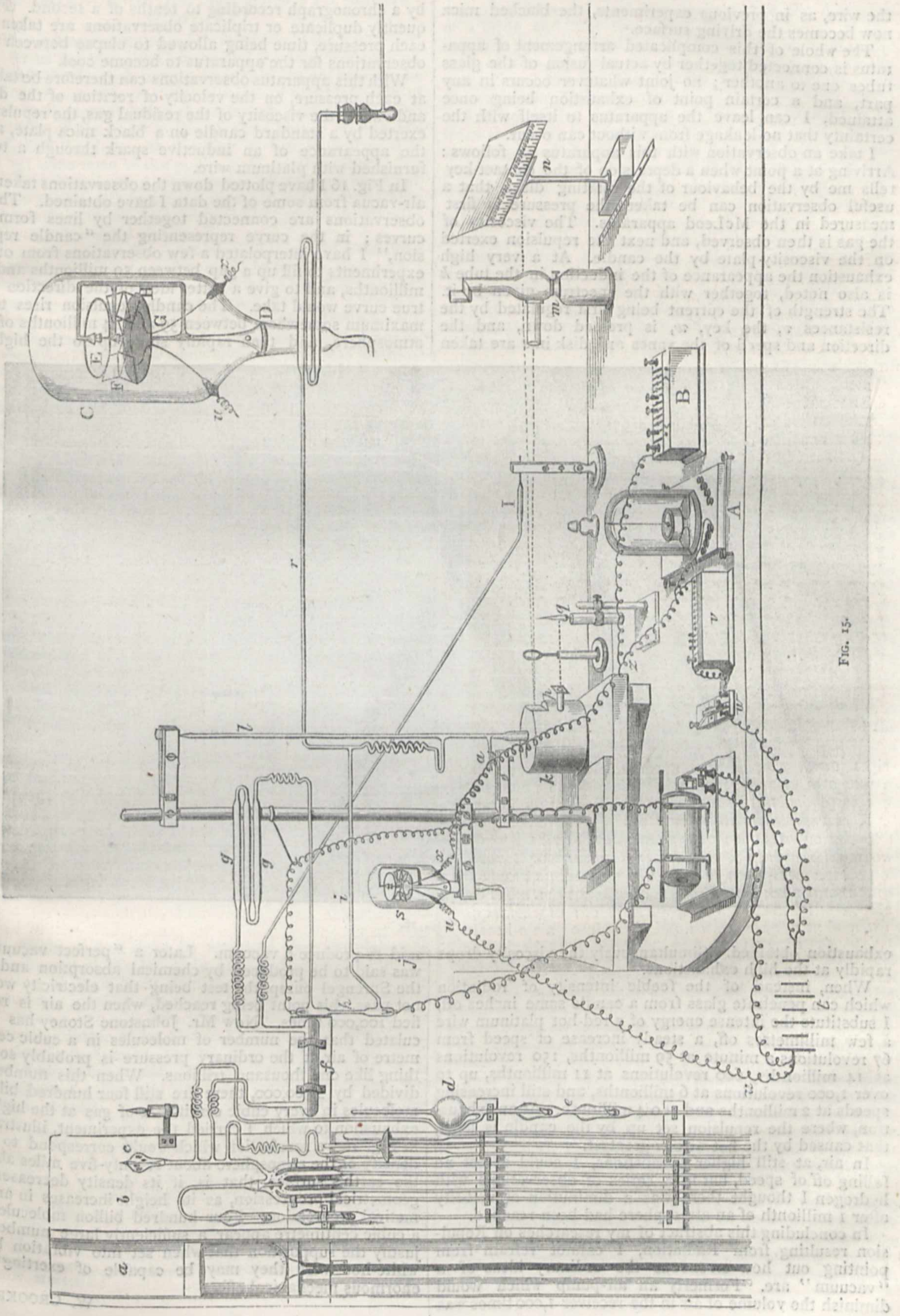

Fig. 15.

the wire, as in previous experiments, the blacked mica now becomes the driving surface.

The whole of this complicated arrangement of apparatus is connected together by actual fusion of the glass tubes one to another; no joint whatever occurs in any part, and a certain point of exhaustion being once attained, I can leave the apparatus to itself with the certainty that no leakage from without can occur.

I take an observation with this apparatus as follows: Arriving at a point when a depression of the contact-key tells me by the behaviour of the rotating disks that a useful observation can be taken, the pressure is first measured in the McLeod apparatus. The viscosity of the gas is then observed, and next the repulsion exerted on the viscosity-plate by the candle. At a very high exhaustion the appearance of the induction in the tube *h* is also noted, together with the spectrum given by it. The strength of the current being first regulated by the resistances *v*, the key, *w*, is pressed down, and the direction and speed of the vanes and disk in *s* are taken by a chronograph recording to tenths of a second. Frequently duplicate or triplicate observations are taken at each pressure, time being allowed to elapse between the observations for the apparatus to become cool.

With this apparatus observations can therefore be taken at each pressure, on the velocity of rotation of the disk and vanes, the viscosity of the residual gas, the repulsion exerted by a standard candle on a black mica plate, and the appearance of an inductive spark through a tube furnished with platinum wire.

In Fig. 16 I have plotted down the observations taken in air-vacua from some of the data I have obtained. These observations are connected together by lines forming curves; in the curve representing the "candle repulsion," I have interpolated a few observations from other experiments to fill up a gap between 59 millionths and 14 millionths, and to give a better idea of the direction the true curve would take. The candle repulsion rises to a maximum somewhere between 59 and 14 millionths of an atmosphere, and then rapidly sinks up to the highest

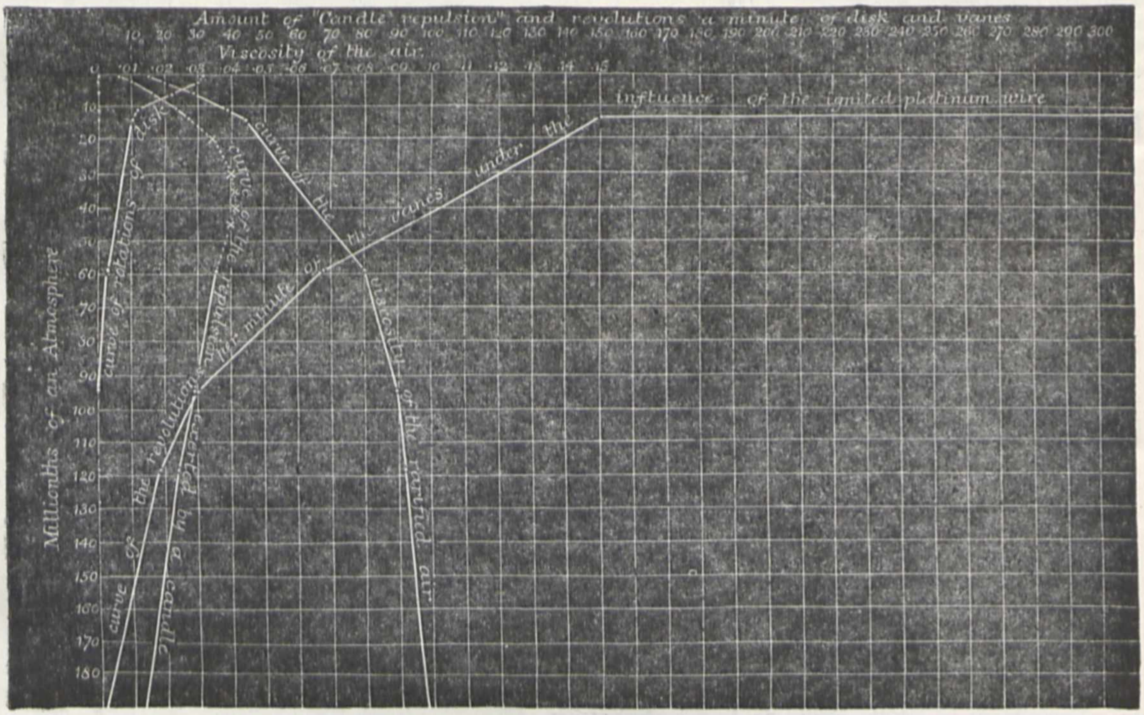

FIG. 16.

exhaustion obtained. Simultaneously the viscosity drops rapidly at the high exhaustions.

When, instead of the feeble intensity of radiation which can penetrate glass from a candle some inches off, I substitute the intense energy of a red-hot platinum wire a few millimetres off, a steady increase of speed from 67 revolutions a minute at 59 millionths, 150 revolutions at 14 millionths, 600 revolutions at 11 millionths, up to over 1,000 revolutions at 6 millionths, and still increasing speeds at 2 millionths and at 0·4 millionth. At an exhaustion, where the repulsion set up by the candle is least, that caused by the hot wire is greatest.

In air, at still higher exhaustions, I could detect no falling off of speed, but in a series of observations with hydrogen I thought there was a diminution of velocity after 1 millionth of an atmosphere had been reached.

In concluding this abstract of my researches on Repulsion resulting from Radiation, I cannot refrain from pointing out how erroneous the ordinary ideas of a "vacuum" are. Formerly an air-pump which would diminish the volume of air in the receiver 1,000 times was said to produce a vacuum. Later a "perfect vacuum" was said to be produced by chemical absorption and by the Sprengel pump, the test being that electricity would not pass, this point being reached, when the air is rarefied 100,000 times. Now Mr. Johnstone Stoney has calculated that the number of molecules in a cubic centimetre of air at the ordinary pressure is probably something like one thousand trillions. When this number is divided by 2,500,000, there are still four hundred billion molecules in every cubic centimetre of gas at the highest exhaustion to which I carried the experiment, illustrated in Fig. 16—a rarefaction which would correspond to the density of the atmosphere about seventy-five miles above the earth's surface, that is, if its density decreases in geometrical progression, as its height increases in arithmetical progression. Four hundred billion molecules in a cubic centimetre appear a sufficiently large number to justify the supposition that when set into vibration by a white-hot wire they may be capable of exerting an enormous mechanical effect.

W. CROOKES

THE MIRROR OF JAPAN, AND ITS MAGIC QUALITY[1]

THE lecturer commenced by referring to the vast differences between the Chinese and the Japanese nations, of which the English people, as a rule, do not seem to be aware. He instanced various points of contrast; one of the most important being the intensely oriental secluded character of the private life of the Chinese on the one hand, and the Japanese dwelling in houses unfurnished and left wide open to the public gaze on the other. But why, he asked, in this comparative absence of nearly all that we should call furniture, does one article pertaining to the ladies' toilet—the bronze mirror with its stand—hold so prominent a position?

This mirror of the Far East is usually circular, from three to twelve inches in diameter, made of bronze, and with a bronze handle covered with bamboo. The reflecting face is generally more or less convex, polished with a mercury amalgam; the back is gracefully ornamented with a well-executed raised design representing birds, flowers, dragons, a geometrical pattern, or some scene in Japanese mythical history. Occasionally there are also one or more Chinese characters (signifying long life, happiness, or some similar idea) of polished metal, in bold relief. The general appearance of the back of the mirror, therefore, is something like that seen in the accompanying figure.

It might at first sight be surmised that the elaborate head-dresses of the ladies in Japan, combined with the painting of their faces, furnished an explanation of the prominence given to the metal mirror. But that this is not the case is easily seen from the fact that it is in the Imperial Palace, where the court ladies, still preserving the simple fashion of ancient days, merely comb back their long black tresses, and so have least need of a looking-glass, that the Japanese mirror receives the highest respect. A foreigner meets the mirror in the temples, in the hands of the street-conjuror, in pictures of the infernal regions, and in the regalia of the Japanese sovereigns, and for some time after his arrival in Japan, feels as an Oriental ignorant of biblical history might when unable to understand the constant repetition of the cross in Roman Catholic countries. But at length he hears that the mirror is part of the Japanese religion and mixed up with the "divine right of kings"; that it is the most precious of the possessions of a Japanese woman, and constitutes the most important part of the *trousseau* of a bride, and "the two Great Divine Palaces" at Isé, in which was deposited the first made mirror, have in the eyes of the Japanese the same importance as has the Holy Sepulchre for the Greeks and Armenians, and Mecca for the Mohammedans.

And to realise the reason of this, the stranger must learn that there is a famous ancient myth in Japan, which was recounted by the lecturer, detailing how the sun-goddess in a rage shut herself up in a rocky cave, and how the other gods to dispel the darkness thus caused, used various artifices to entice her forth, the most successful ruse being the manufacture of the first historical mirror, in which, seeing her face, she was drawn forth by her curiosity and jealousy. He will also learn how in the supposed creation of the Japanese Empire, the sun-goddess is reputed to have handed this mirror (with the two other "god's treasures," which, together with a mirror, at present constitute the regalia of the Emperor) to her grandson with these words, "Look upon this mirror as my spirit, keep it in the same house and on the same floor with yourself, and worship it as if you were worshipping my actual presence."

After describing many interesting points in connection with this strange mirror-worship of the Japanese, as seen in the palace and in the cottage, the lecturer went on to say that to the majority of those present the investigation of the so-called *magic* properties of the Japanese mirror would probably prove of yet more interest.

This magic property, which is possessed by a few rare specimens coming from the East, is as follows: If the polished surface is looked at directly, it acts like an ordinary mirror reflecting the objects in front of it, but giving, of course, no indication whatever of the raised patterns on the back; if, however, a bright light be reflected by the smooth face of the mirror on to a screen, there is seen on this screen an image formed of bright lines on a dark ground more or less perfectly representing the pattern on the back of the mirror, which is altogether hidden from the light.

When this appearance is seen for the first time it is perfectly startling even to an educated mind, and if the source of light is sufficiently bright, as for instance a tropical sun, it is difficult for the observer to divest himself of the idea that the screen is not perforated with cuts, corresponding with the pattern on the back of the mirror, and illuminated from behind.

This strange phenomenon was known to both Sir David Brewster and Sir Charles Wheatstone, both of whom were of opinion that it was produced by trickery on the part of the maker. Sir David Brewster, for example, says in the *Philosophical Magazine* for December, 1832: "Like all other conjurors, the artist has tried to make the observer deceive himself. The stamped figures on the back (of the mirror) are used for this purpose. The spectrum in the luminous area *is not an image of the figures on the back.* The figures are a copy of the picture which the artist *has drawn on the face of the mirror*, and so concealed by polishing that it is invisible in the ordinary lights, and can be brought out only in the sun's rays."

Prof. Ayrton then related how he had been quite unable to find for sale in any of the shops of Japan one of these magic mirrors, which was supposed in Europe to be a standard Japanese trick, and he explained how he had at length ascertained that with regard to this so-called magic mirror, the Japanese were the people who knew least about the subject.

But these magic mirrors were known to the Chinese from the earliest times, and one of their writers spoke about them in the ninth century of the Christian era. They call them *theou-kooang-kiĕn*, which means literally, "mirrors that let the light pass through them," this name,

[1] The Friday evening discourse at the Royal Institution, January 24, by Prof. W. E. Ayrton.

of course arising from a popular error on the subject. The Roman writer Aulus Gellius, who lived seventeen centuries ago, referred to mirrors that sometimes reflected their backs and sometimes did not. From the great antiquity of these Chinese magic mirrors, the German writer Herr Sterne has concluded that it is probable that the mirrors with secret signs and figures of imps on the back, which formed a portion of the stock-in-trade of the witches of the middle ages, were of Eastern manufacture. The Italian historian Muratori gives an account of the magic mirror found under the pillow of the Bishop of Verona, who was afterwards condemned to death by Martin Della Scala, as well as of the one discovered in the house of Colla da Rienzi, and on the back of which was the word "Fiòrone." But of these magic mirrors, which have played so important a part, not only in the priestcraft of China, but also in the oracles of the Greeks and Etruscans, and in the witchcraft of the middle ages, inquiry has shown that Japanese literature makes absolutely no mention.

Is it, then, that such mirrors cannot be found in Japan? Undoubtedly they cannot be bought on inquiry at the shops, but Prof. Ayrton's investigations have shown that if a careful examination with properly arranged light be made of a large number of the ordinary Japanese bronze mirrors, a few, perhaps 2 or 3 per cent., will be found showing the magic property clearly.

The lecturer then referred to the extracts he had made from a large portion of that which had been written in various languages regarding the explanation of the phenomenon. He mentioned that the earliest explanation was given by a Chinaman, Ou-tseu-hing, who lived between 1260 and 1341, and who also had the impression that the magic property of the mirror was produced by an artifice; for he wrote: "When we turn one of the mirrors with its face to the sun, and allow it to throw a reflection on a wall close by, we see the ornaments or the characters which exist in relief on the back, clearly. Now the cause of this phenomenon arises from the employment of two kinds of copper of unequal density. If on the back of the mirror a dragon has been produced while casting it in the mould, then an exactly similar dragon is deeply engraved on the face of the disk. Afterwards the deep chisel cuts are filled up with denser copper, which is incorporated with the body of the mirror, which ought to be of finer copper, by submitting the whole to the action of fire; then the face is planed and prepared, and a thin layer of lead or of tin spread over it.[1]

"When a beam of sunlight is allowed to fall on a polished mirror prepared in this way, and the image is reflected on a wall, bright and dark tints are distinctly seen, the former produced by the purer copper, and the latter by the parts in which the denser copper is inlaid."

Ou-tseu-hing adds that he has seen a mirror of this kind broken into pieces, and that he has thus ascertained for himself the truth of this explanation.

In a paper communicated some years ago to the French Academy of Sciences, the well-known French writer on China, M. Stanislaus Julien, says: "Many famous philosophers have for a long time, but without success, endeavoured to find out the true cause of the phenomenon which has caused certain metallic mirrors constructed in China to have acquired the name of magic mirrors. Even in the country itself where they are made, no European has up to the present time been able to obtain either from the manufacturers, or from men of letters, the information which is so full of interest to us, because the former keep it a secret when by chance they possess it, and the latter generally ignore the subject altogether. I had found many times in Chinese books details regarding this kind of mirrors, but it was not of a nature to satisfy the very proper curiosity of the philosopher, because sometimes the author gave on his own responsibility, an explanation that he had guessed at, and sometimes he confessed in good faith that this curious property is the result of an artifice in the manufacture, the monopoly of which certain skilled workmen reserve to themselves. One can easily understand this prudent reticence when we remember that the rare mirrors which show this phenomenon sell from ten to twenty times as dear as the rest."

[1] This probably refers to the mercury-amalgam which is used in polishing, and which Ou-tseu-hing mistook for lead or tin.

The prevalent idea has been that the phenomenon of the magic mirror was caused by a difference of density in the various parts of the surface, either produced intentionally or accidentally; and this, the lecturer explained, arose from two causes, first, from the common belief that the patterns on Japanese and Chinese mirrors were, like those on ordinary coins, produced by stamping; the other, because the distinguished European philosophers who had examined into the question had investigated with considerable success, experimentally, how such mirrors might be made, but they had not, the lecturer thought, directed their attention to the examination of the question—How was the phenomenon in these rare eastern mirrors actually produced?—obviously a very different question.

Prof. Ayrton mentioned that he and Prof. Perry were led to take up the investigation from a very remarkable fact pointed out by Prof. Atkinson, of Japan, viz., that a scratch with a blunt iron nail on the back of one of these magic mirrors, although it produced no mark on the face of the mirror which could be seen by direct vision, nevertheless became visible as a bright line on the screen when a beam of sunlight was reflected from the polished face of the mirror. The lecturer mentioned that after trying several experiments with polarised light, &c., Prof. Perry and himself availed themselves of a very simple method of investigation, but one which had apparently not suggested itself to previous observers. On one occasion, when some of their students were using lenses to endeavour to make the exhibition of the phenomenon more striking, it occurred to them that the employment of beams of light of different degrees of convergence or divergence would furnish a test for deciding the cause of the whole action. For while, if the phenomenon were due to the molecular differences in the surface—the commonly received opinion—the effect would be practically independent of the amount of convergence of the beam of light; on the other hand, if it by any chance were due to portions of the reflecting surface being less convex than the remainder, a complex *inversion* of the phenomenon might be expected to occur, if the experiment, instead of being tried in ordinary sunlight, were made under certain conditions in a converging beam—that is, the thicker portions of the mirror might be expected to appear darker instead of lighter than the remainder.

[Experiments were then shown of the image cast on the screen: (1) when a divergent beam of light fell on the mirror, (2) when the beam was parallel, (3) when the beam was convergent; and it was seen (1) the pattern appeared as bright on a dark ground, (2) the pattern was invisible, (3) the pattern appeared as dark on a light ground.]

Again, by allowing a parallel beam of light to fall on it, and interposing a double convex lens between the mirror and the screen, we can make the image show the pattern either as a bright on a dark ground, or as dark on a bright ground, or not at all, merely by causing the screen to be: 1st, nearer the lens than the conjugate focus of the mirror; 2nd, farther than the conjugate focus; 3rd, at the conjugate focus. [This experiment was here shown.] Now it can easily be proved by simple geometrical optics that each of these effects would be produced if the thicker parts of the mirror were a little less convex than the remainder. [This was explained by various geometrical diagrams.] And lastly, if the phenomenon was, as the previous experiment would lead us to conclude, due not to unequal reflecting power of the different portions of the surface of the mirror, but to minute inequalities on the surface, in consequence of which there is more scattering power of the rays of light falling on one portion than on another, then, since rays of light making very small angles with one another do not separate perceptibly until they have gone some distance, it follows that if the screen be held *very near* to the mirror, the apparent reflection of the back, the magical property, in fact, ought to become invisible. And this also, it was shown, was exactly what happened when the screen was made almost to touch the polished surface.

The lecturer then proceeded to explain why a *divergent* beam emitted by a bright luminous *point* at some fifteen feet distance from the mirror gave the best effects.

We have therefore strong reasons for favouring the "inequality of curvature" theory. In order, however, to make the explanation quite certain, the lecturer said he had made a small concavity and a small convexity on the face of one of the mirrors, by hammering with a blunt tool, carefully protected with a soft cushion to avoid scratching the polished surface, and he showed by experiment that the concavity reflected a bright image and the convexity a dark one, when the pattern on the back appeared bright, but when the light was so arranged that the pattern appeared as dark on a bright ground, it was the convexity which appeared as the bright spot and the concavity as the dark one.

Guided by all that precedes, we are led to the undoubted conclusion that the whole action of the magic mirror arises from the thicker portions being flatter than the remaining convex surface, and even being sometimes actually concave. But, in spite of this irresistible conclusion forced on us by the experiments previously mentioned, it must be admitted that it seems extraordinary how such small inequalities in the surface of the mirror, so small in fact that the eye quite fails to detect them, can, even with a proper arrangement of the light, produce on the screen an image of the pattern on the back as sharp and clear as is seen with a good specimen of the magic mirror.

The next question arises, why is there this difference in the curvature of the different portions of the surface? The experience that Prof. Ayrton had gained from an examination of a large number of Japanese mirrors supplied, in part at any rate, the answer to the question. No thick mirror reflects the pattern on the back, not one of the many beautiful mirrors exhibited at the National Exhibition of Japan in 1877, and which the lecturer was so fortunate as to be able to experiment with in a darkened room with a bright luminous point at some twelve feet distance, showed the phenomenon in the slightest degree; some good old mirrors in the museum of the Imperial College of Engineering, and which belonged to the family of the late Emperor, the Shogun, of Japan, failed to reflect any trace of a design, and some old round mirrors without handles, which he had also tried, were (with the exception of one which was immensely prized, and brought to him wrapped in five distinct silk cases, and the heirloom of the family of a nobleman) equally unsuccessful.

Again, it is not that the pattern is less clearly executed on the backs of these choice mirrors, since the better the mirror the finer and bolder is the pattern, but what is especially noticeable is that every one of these mirrors is, as a whole, far thicker than an ordinary Japanese mirror, and its surface is much less convex.

This naturally led him to inquire how are Japanese mirrors made convex? Are they cast so, or do they acquire this shape from some subsequent process? His search through all the literature at his disposal—European, Japanese, Chinese—on the subject of mirrors failed to elicit the slightest hint; he was therefore compelled to perform the somewhat difficult task of obtaining information from the Japanese workmen themselves. Eventually he ascertained that while practically all Japanese mirrors were convex, the surface of each half of the mould was flat, and that the curvature was given to the mirror after casting in the following way: the rough mirror is first scraped approximately smooth with a hand-scraping tool, and as this would remove any small amount of convexity had such been imparted to it in casting, it is useless to make the mould slightly convex. If, however, a convex or concave mirror of small radius is required, then the surface of the mould is made concave or convex. On the other hand, to produce the small amount of convexity which is possessed by ordinary Japanese mirrors the following method is employed, if the mirror is thin, and it is with thin mirrors we have especially to deal, since it is only in these mirrors that the apparent reflection of the back is observed. The mirror is placed face uppermost on a wooden board, and then scraped or rather scratched with a rounded iron rod about a third of an inch in diameter, and a foot long, called a *megebo*, "distorting rod," so that a series of small parallel scratches is produced, which causes the face of the mirror to become convex in the direction at right angles to the scratches, but to remain straight parallel to the scratches, in fact it becomes very slightly cylindrical, the axis of the cylinder being parallel to the scratches. This effect is very clearly seen by applying a straight-edge in different ways to the face of an unpolished mirror which has received a single set of scratches only. A series of scratches is next made with the *megebo* in a direction of right angles to the former, a third set intermediate between the two former, and so on, the mirror each time becoming slightly cylindrical, the axis of the cylinder in each case being parallel to the line of scratches, so that eventually the mirror becomes generally convex. Some workmen prefer to make the scratches with the *megebo* in the form of small spirals, others in the form of large spirals, but the general principle of the method employed with their mirrors appears to be always the same—the face of the mirror is scratched with a blunted piece of iron, and becomes slightly convex, the back, therefore, becoming concave.

[Mirrors were here exhibited, one with its surface flat, although somewhat rough, just as it came from the mould after casting; a second that had received one set of parallel scratches with the *megebo*, and which by means of a straight edge was shown to be slightly cylindrical; and a third on the face of which the operation of scratching had been completed, and which was therefore slightly convex.]

After the operation with the "distorting-rod" the mirror is very slightly scraped with a hand-scraping tool to remove the scratches, and to cause the face to present a smooth surface for the subsequent polishing.

In the case of thick mirrors the convexity is first made by cutting with a knife, and the distorting-rod applied afterwards. But in connection with this cutting process of thick mirrors, there is one very interesting point. If the maker finds, on applying from time to time the face of the mirror to a hard clay concave pattern, and turning it round under a little pressure, that a portion of the surface has not been in contact with the pattern, in other words, that he has cut away this portion too much, then he rubs this spot round and round with the *megebo* until he has restored the required degree of convexity. Here again, then, scratching on the surface produces convexity.

Now, why does the scraping of the "distorting rod" across the face of the mirror leave it convex? During the operation it is visibly concave. The metal must receive, then, a kind of "buckle," and spring back again so as to become convex when the pressure of the rod is removed. It might in such a case reasonably be expected that the thicker parts of the mirror would yield less to the pressure of the rod than the thinner, and so would be made less convex, or even they might not spring back, on the withdrawal of the rod and so remain actually concave. Again, since we find that scraping the face of the mirror is the way in which it is made convex, and the back therefore concave, we might conclude that a deep scratch on the back would made the back convex and the face slightly concave. Such a concavity would, as we have proved, explain the phenomenon of the bright line appearing in the reflection of sunlight on the screen, which was observed by Prof. Atkinson to correspond with the scratch on the back.

After the scratches produced by the *megebo* are removed the mirror is polished with whetstones and then with charcoal. The face now becomes fairly smooth, but it still generally contains some few cavities; these the maker fills up from a stock of copper balls of various sizes which he has at hand. (It was probably the presence of these bits of copper that led Ou-tseu-hing to believe that the explanation of the cause of the magic mirrors was the inlaying of different metals.) The face of the mirror is finally rubbed over with a mercury amalgam containing 50 per cent of tin, by means of a small straw brush or the hand.

The lecturer then referred to the various metal mixtures employed by the Japanese in making their mirrors, the best being composed of 75 per cent. of copper, 23 of tin, and 2 per cent. of a natural sulphide of lead and antimony.

Although the Japanese have paid no attention to the magic mirror, which has created such interest in Europe, they have, in connection with their priestcraft, employed mirrors on the surface of which, if looked at obliquely, could be seen the faces of saints, but which were not in any way connected with the pattern on the back of the mirror. [Photographs of such mirrors were projected on to the screen.] The lecturer also exhibited two mirrors of this kind which he had had made in consequence of the belief expressed by one of the Japanese mirror-makers that the phenomenon of the so-called magic mirrors was produced by chemical action on the surface. But the result of the experiment had been that if the face of a mirror which had been chemically acted on was polished until every trace of the marks disappeared for direct or oblique vision, then they also disappeared in the image produced by reflecting a beam of light on to a screen, and consequently that it did not seem possible, as far as his experiments had gone, to produce, by means of chemical action on the surface, a mirror fulfilling all the conditions of the magic mirror.

He concluded by saying: "It appears, then, contrary to what is commonly believed, that the magic of the Eastern mirror results from no subtle trick on the part of the maker, from no inlaying of other metals or hardening of portions by stamping, but merely arises from the natural property possessed by certain thin bronze of buckling under a bending stress, so as to remain strained in the opposite directions after the stress is removed. And this stress is applied partly by the distorting rod, and partly by the subsequent polishing, which, in an exactly similar way, tends to make the thinner parts more convex than the thicker."

GEOGRAPHICAL NOTES

THE April number of Petermann's *Mittheilungen* contains a paper of considerable geographical and geological value by Dr. Edmund Naumann, on the Plain of Yedo, Japan; it is accompanied by several illustrations and a fine map. Lieut. Onatzewich's account of his cruise in the clipper *Wssadnik* to the north of Behring Strait in 1876, is well timed in connection with the *Vega's* sojourn in that region. Dr. von Scherzer contributes an interesting paper on anthropometry, and Capt. Johannesen describes the voyage of the *Lena* from the mouth of the River Lena to Jakutsk. The monthly summary contains, as usual, many interesting items.

THE February number of the *Bulletin* of the Paris Society gives M. Savorgnan de Brazza's paper on his Ogowé expedition, the results of which we have already stated. A valuable and detailed notice of Dalmatia is contributed by M. de Sainte-Marie, and the number contains the recent correspondence of Dr. Crevaux from Guiana, referred to last week. The *Nouvelles* are continued.

AS we stated last week, though M. Soleillet has got so far on his journey to Timbuktu, it must not be forgotten that some fifteen years ago Lieut. Mage and Dr. Quintin reached the same place, and that after being detained as prisoners for eighteen months by the present Sultan Ahmadu, they were refused permission to embark on the Niger, and compelled to return to the coast *re infectâ.* Indeed, just as we go to press we learn that a telegram sent to the French Société de Géographie announces that the progress of M. Soleillet has been cut short. He was stopped by Ahmadu, the Emperor of Segou under the pretence that the roads are insecure in the north of his government. M. Soleillet has returned to St. Louis.

WITH reference to our note last week (p. 516) on the Conference in connection with the Inter-oceanic Canal, M. Maunoir, Secretary of the Paris Geographical Society, writes us that the Conference is to be held on May 19 under the auspices of that Society and not of the Society of Commercial Geography. The Congress, M. Maunoir writes, will not have any particular project in view, but will give an impartial hearing to the various projects brought before it. The various solutions of the questions proposed will be propounded by their authors, and, if deemed advisable, the Congress may in the end give its approval of one or other of the projects.

THE April number of the *Church Missionary Intelligencer* states that letters have been received from the missionary reinforcements who are travelling up the Nile to join the Nyanza expedition. They only reached Lado opposite Gondokoro, on October 10; after three weeks stay at that Egyptian station they reached Regiaf on November 7. The cause of delay, we are told, has been that the Nile has been unusually high, and the immense quantity of water loosened great masses of reeds and papyrus which formed floating islands and blocked up the river, besides which, owing to a deficiency of fuel between Khartoum and Lado, they remained fast bound during the whole month of September some distance south of Sobat, and the missionaries saw no living beings (besides the men on board) but "pelicans, fishes, and a white-headed eagle or two."

ANNEXED to the recently issued report of Her Majesty's Consul on the newly-opened port of Wênchow, is a very interesting map of the three Chinese provinces of Chekiang, Fukien, and Kiangsi, showing the means of communication by land and water between the principal cities and districts. The object of the map is more especially to point out the position of Wênchow as regards some of the most important districts in these provinces, the names of which with their products are given.

GARIBALDI has snubbed the Italian New Guinea expedition, so that it may now be regarded as nipped in the bud.

THE collection of funds instituted by the Dutch Central Committee for Arctic Exploration for the renewed outfitting of the *Willem Barentz*, which vessel is shortly to start on another expedition of some eighteen months' duration, is progressing so favourably that it may be reasonably expected that the 50,000 florins which are required for the expedition will soon be completely subscribed.

NOTES

In the interests of British science we have refrained now for some time from referring to the evil days which have fallen upon one of the most reputable of our learned societies. The time, however, has now come when silence is impossible. At the meeting of the Royal Astronomical Council yesterday, the Astronomer-Royal, in consequence of the recent action of the Council—an action inevitable when the present constitution of that body is considered—resigned his seat at the board. We cannot too much regret that this Society, the traditions of which are second to none in Europe, should have been utilised for some years past by an advertising clique who have everything to gain by their connection with a body of honourable students of science. The withdrawal of men long known for their astronomical work from the Council commenced some time since. It has now culminated in the resignation of the Astronomer-Royal, and we are informed that other resignations are to follow; indeed, a man of scientific repute risks somewhat in being found amongst the Councillors. Surely the Fellows of the Royal Astronomical Society of London are strong enough to remedy such a state of things as this.

At the meeting of the Council of the Royal Society, held last Thursday, the following fifteen candidates were selected to be recommended for election. The day fixed for the election is Thursday, June 12:—J. Anderson, M.D., Rev. M. J. Berkeley, H. Bessemer, Prof. A. Crum-Brown, W. L. Buller, Sc.D., G. H. Darwin, Prof. J. D. Everett, Prof. F. S. B. François de Chaumont, Prof. G. D. Liveing, G. Matthey, G. J. Romanes, A. Schuster, Ph.D., Prof. H. G. Seeley, B. Williamson, and T. Wright, M.D. The following have been elected Foreign Members of the Society:—Arthur Auwers, Berlin; Luigi Cremona, Rome; Jean Louis Armand de Quatrefages, Paris; Georg Hermann Quincke, Heidelberg; Theodor Schwann, Liége; Jean Servais Stas, Brussels.

Macmillan and Co. will publish shortly the following literary and scientific remains of the late Prof. W. K. Clifford. (1) A volume of mathematical papers which have been read before the Royal Society or contributed to scientific journals; Mr. Wm. Spottiswoode, F.R.S., will probably see this collection through the press. (2) Two volumes of collected essays and lectures, edited by Mr. Leslie Stephen and Mr. Frederick Pollock; Mr. Pollock will also contribute a biographical introduction to this work. (3) A small volume containing three popular lectures on "Seeing and Thinking."

We regret to see by the Civil Service Estimates that the amount to be devoted to "Purchases and Acquisitions" in the Department of Zoology of the British Museum during the present financial year has been reduced by one-fourth, *i.e.*, from 1,200*l.* to 900*l.* It seems rather absurd that a Government which has shown its anxiety to meet the claims of science by giving 4,000*l.* a year to be distributed in "aid of research" by the Royal Society, should have taken such a step as this to save a miserable 300*l.*, especially when it was the universal complaint of naturalists that the sum previously granted was wholly inadequate to the purpose. We cannot help thinking that the Trustees and their Secretary are in fault in this matter.

A further circular, in addition to that referred to on p. 472, has been issued by the Meteorological Office, with regard to the conditions on which weather information will be supplied. These conditions are too detailed to be noticed here, but they show a desire on the part of the Office to give every facility both to residents in London and in the country to obtain descriptions of the actual state of the weather and forecasts for not more than one day in advance. No doubt a copy of the circular may be obtained on application at the Office, 116, Victoria Street, S.W.

M. Renan was elected a few months ago a member of the Académie Française to fill the place vacated by the demise of M. Claude Bernard, the celebrated physiologist. On Monday, last week, he pronounced, before an immense audience, the *éloge* of his predecessor, in which he mentions that Claude Bernard must be considered as being the real founder of physiology in France. No public course of lectures was given before 1845, when M. Bernard established a laboratory, in the rue Saint Jacques, near the Panthéon. It was in this institution that the illustrious Academician conceived the idea of the great experiments which rendered his fame universal. But the establishment failed, M. Bernard having collected not more than five or six pupils.

The Council of the Society of Arts offers one gold and three silver medals for the best suggestions founded upon evidence already published, for dividing England and Wales into districts for the supply of pure water to the towns and villages of each district.

"A Citizen and Fishmonger" very pertinently asks in Tuesday's *Times* why it is that while we hear so much from time to time of the City Guilds' Technical College, and of the Society for University Extension in London, we hear nothing of any proposal for the utilisation of Gresham College?

The *Times* Geneva correspondent writes that the Lake of Neuchâtel is just now lower than has ever before been known, and continues to yield rich rewards to the researches of antiquarian explorers. Prof. Forel found, a few days since, at the lacustrine station of Corcelet, an earthenware vase dating from the age of bronze. On the bottom of the vase are plainly visible the impressions made by the fingers of the prehistoric potter in the plastic clay. Of these fingers—or, rather, of the thumb and forefinger, for the other digits are unfortunately lacking—the professor has taken a plaster of Paris cast and submitted them to a minute examination. He pronounces the maker of the vase to have been a woman. There are two impressions of the thumb and three of the forefinger. The prints left by the nails are perfect—that of the thumb, which must have been regular, well-shaped, and of an elegant convexity, measures in length twelve millimetres, in breadth eleven millimetres; the length and breadth of the finger-nail, equally well modelled, are eleven and nine millimetres respectively, the transverse convexity representing a curve or rise (*flèche*) of two millimetres. These nails, considers M. Forel, can only have belonged to a female hand. The vase has been placed in the cabinet of antiquities in the Vaudois Cantonal Museum at Lausanne. Another investigator, who has been cutting trenches in ground left bare by the abatement of the waters of the lake, has arrived, after careful examination of the *débris* and relics which his explorations have brought to light, at some interesting conclusions concerning the way in which certain of these lake-dwellings were destroyed, the time of the year when they disappeared, and the level of the lake at the epoch of their extinction. He believes they were destroyed by fire. This opinion he bases on the fact that, in all his explorations, he finds the same mixture of gravel and sand blackened and interspersed with charcoal and partly burnt seeds and bits of wood. This *débris* has evidently been carried to its present position by the waters of the lake, and varies in thickness according to the inclination of the slope on which it has been deposited. In other places besides those where the trenches have been cut, similar indications are observable—for example, at Bied, where, in sinking for the foundations of a house, a lacustrine cemetery was some time ago discovered; and at Colombier, where a stream running over the dry bed of the lake near the shore has laid bare *débris* identical with that brought to light by the excavations in question. From the quality and quantity of the winter stores, such as nuts, seeds, and berries, found among these remains, the burning of the lake-dwellings probably occurred in spring or early summer. In one place a vessel was found filled with acorns, which, not being a favourite food, would naturally, it is presumed, be left to the last, and only used in default of something more palatable. From these facts and considerations it is inferred that at the time when many, if not all, the lake villages of Neuchâtel fell a prey to the flames, its waters were at the height usual with them in spring before their level had been artificially lowered by the engineering operations recently undertaken for confining within their channels the streams of that part of the Jurassic range which dominates the valleys of Neuchâtel and Morat.

THE death is announced, on Tuesday, at the age of eighty-two years, of Sir Anthony Panizzi, formerly Principal Librarian of the British Museum.

WE regret to announce the death of Herr Ludwig Reichenbach, an eminent German botanist and zoologist. He died at Dresden on the 18th ult., aged 86 years.

THE German scientific world is much gratified at the distinction conferred upon Dr. Julius Schmidt, of Athens, by the French Academy of Sciences, which recently honoured Dr. Schmidt by presenting him with the Prix Volz in recognition of his work on the moon. This prize is only given for important astronomical work, and has not been awarded since 1870.

THE various German societies for the protection of animals are now keenly discussing the vivisection question and have arranged a congress, which will shortly meet at Gotha, and which is to fix the final resolutions.

DR. J. E. TAYLOR has concluded the seventh winter series of scientific discourses at the Ipswich Museum. These have been free, and the average attendance has been 500 per night. Dr. Taylor regards the local collection of the Ipswich Museum as probably one of the best geological museums in Europe. He deserves credit for his exertions in spreading a knowledge of science in the district in which he lives.

ON Easter Monday and following day, the Geologists' Association will have an excursion to Weymouth and Portland.

WE have received a small pamphlet of eighty pages, containing the numerous opinions which have been expressed on Prof. Church's position with reference to the Agricultural College at Cirencester. The result of the conduct of the College authorities is likely to be the establishment of a rival institution, to be ready in October next. If it be the case, as is so generally alleged, that the Cirencester institution is a failure so far as agricultural education is concerned, we cannot be sorry that steps should be at once taken to supply the want.

WE have received the first two parts of a very fine "Atlas of Histology," by Dr. Klein and Mr. E. Noble Smith. The work is intended to be a pictorial and literal representation of the structure of the tissues of man and other vertebrates, its chief aim being to teach not so much the history of histology as histology itself in its modern aspect. The delicate illustrations are executed with wonderful care and beauty.

THERE was a slight shock of earthquake on the 3rd inst. at Cadiz.

IN the year 1877 Mr. Clark Mills, of Washington, the well-known sculptor, visited St. Augustine, Florida, in the interest of the Smithsonian Institution and of the Peabody Museum in Cambridge, for the purpose of taking casts of the heads of certain Indian prisoners in Fort Marion. These prisoners had been captured some years before, and sent to Florida for safe keeping, and were in charge of Capt. R. H. Pratt, of the Army. Most of them had been guilty of grave offences against life and property. A visit to and interviews with these Indians have constituted the staple of the correspondence of visitors to St. Augustine for several years past. During the year 1878 this station was broken up, some of the Indians being released, and others transferred to Hampton, Virginia, where, under the charge of General Armstrong, there is an establishment for the education of certain negroes. By authority of the War Department, Capt. Pratt has recently gathered up a large number of Indian youth of both sexes, and taken them to Hampton, where they are subjected to moral and mental training, and show a great aptitude for learning. Quite recently, at the request of the Smithsonian Institution, Mr. Mills visited Hampton, and with the assistance of Capt. Pratt, has made a series of excellent casts of some fifty Indians of both sexes and different ages. They will in time be reproduced, properly worked up, and exhibited in the National Museum, which will thus, in more than a hundred busts from life of the American aborigines, possess a very remarkable anthropological collection. Numerous applications have been received from the anthropological museums of Europe for copies of these busts.

THE Gauss monument for the city of Brunswick is now very nearly completed, the casting taking place in the studio of Prof. Howald, at Brunswick, after Herr Schaper's model, the well-known Berlin sculptor. The figure will measure nine feet in height, and the great mathematician is represented in a fur coat with a book in his left hand, bearing the inscription "Disquisitiones," the work which rendered his name immortal. The head is said to be a masterpiece of the plastic art.

SOME new experiments on digestion (in which portions of the stomach in living dogs were isolated, and their phenomena studied) have been recently described by Herr Heidenhain in Pflüger's *Archiv*. He arrives at these two (preliminary) conclusions:—(1) Purely mechanical stimulation acts only locally on secretion of gastric juice; (2) The secretion (act), however, extends beyond the place of stimulation to distant parts of the mucous surface, when absorption occurs at that place. In other words, we must distinguish a primary and a secondary secretion. The primary is small and is produced by mechanical effect at the place of stimulation; the secondary is abundant and depends on the act of digestion, in so far as absorption is connected with this, in the stomach.

WE learn that experiments have been made at Mont Valérien by the French Ministry of War with a number of portable Gramme electro-magnetic machines and portable lenses for directing the rays to a great distance and exploring the horizon during night with the same accuracy as during open daylight. The optical apparatus is mounted on a special waggon and weighs no more than two or three tons. It has been ascertained that the machines can travel with the same velocity as mounted artillery. The electric light and directing-lines can also be used for signalling in a known direction at an immense distance, as from Paris to Orleans, if placed at a sufficient altitude.

RECENT researches by Herr Ammon prove that the gas-absorption of dry ground depends on various factors—varying with the state of mechanical division, and chemical nature of the constituents of the ground, and the temperature and nature of the gas. (Quartz, clay, lime, hydrated iron oxide, gypsum, and humus were examined as to their behaviour with various gases of the atmosphere and the ground under different conditions.) Physical forces have an undoubted *rôle* in the condensation, *i.e.*, the gases are held and condensed by surface-attraction of the particles of the soil; and as this attraction is a function of the surface the effect is greater the smaller the particles. But chemical forces seem to have often a larger share in the effects; this appeared most distinctly in the remarkable absorbing power of hydrated iron oxide, and soils containing most of it; which can only be attributed to chemical changes undergone on access of gases, in consequence of the easy decomposition of the constituents. The same holds good for humus materials; whereas with the other constituents the physical "moment" comes out more prominently. Those gases which are easily brought into the liquid state (H_2O, H_2S, CH_4, NH_3, and CO_2), and which undergo changes easily (NH_3, SH_2), are absorbed in greater measure by the constituents of soils, than gases which are not readily liquefied (O). Temperature has great influence; with increase of it the power of condensing gases diminishes. It is notable that at temperatures between 0° and 10° the gas absorption again diminishes. (A fuller account of these researches will be found in *Der Naturforscher* for March 15.)

ANOTHER new Italian journal has come to hand, *Vita Nuova*, published fortnightly. It is devoted to literature, science, and art, and the scientific notes seem to us to be done with care and discrimination, containing occasional information on scientific work in Italy. It is published at Padua.

THE *Colonies and India* states that excellent accounts have been received from Tasmania. Stone exceedingly rich had been discovered in the Alpine reef, Fingal district, estimated to yield 200 ounces of gold to the ton. Gold had also been discovered at Castray River in the North Meredith Range on the west coast.

MM. FIGUIER AND DE PARVILLE have issued their *Annêe Scientifique*, which is a summary of all the notable discoveries made during the past year.

THE additions to the Zoological Society's Gardens during the past week include a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. E. J. Redman; a Red and Yellow Macaw (*Ara chloroptera*) from South America, two Yellow-fronted Amazons (*Chrysotis ochrocephala*) from Guiana, presented by Mrs. Kelly; two Silver Pheasants (*Euplocamus nycthemerus*) from China, presented by Mr. W. Soper; two Bernicla Geese (*Bernicla leucopsis*), two Brant Geese (*Bernicla brenta*), a Bean Goose (*Anser segetum*), two Common Geese (*Anser domesticus*), two Ruddy Sheldrakes (*Tadorna rutila*), two Common Pintails (*Dafila acuta*), two Gadwalls (*Anas strepera*), four Chiloe Widgeons (*Mareca chiloensis*), two Common Widgeons (*Mareca penelope*), two Garganey Teal (*Querquedula circia*), two Common Teal (*Querquedula crecca*), European, four Canada Geese (*Bernicla canadensis*), a Summer Duck (*Aix sponsa*) from North America, two Mandarin Ducks (*Aix galericulata*) from China, three Australian Wild Ducks (*Anas superciliosa*) from Australia, a Wild Goose (*Anser ferus*), three Common Ducks (*Anas boschas*), British Isles, presented by Mr. R. J. Balston, F.Z.S.; a Tuberculated Lizard (*Iguana tuberculata*) from Trinidad, presented by Dr. J. F. Chittenden, C.M.Z.S.; two Mississippi Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Lord Francis Conyngham, M.P., F.Z.S.; a Common Lobster (*Astacus vulgaris*), British Seas, presented by Mr. R. J. Milestone; two White-rumped Roe Deer (*Capreolus pygargus*) from Eastern Asia, a Chinese Water Deer (*Hydropotes inermis*) from China, received in exchange; two Common Boas (*Boa constrictor*) from South America, deposited; eight Indian Jerboa Rats (*Gerbillus indicus*) from India, purchased.

VIRCHOW ON THE PLAGUE

AT a recent meeting of the Medical Society of Berlin Prof. Virchow gave (by previous request) his views on the subject of the Plague of Astrakan. The following is a brief outline of his address (which appears in the *Revue Scientifique*):—

The information received about the plague is very uncertain and conflicting, necessitating reserve in giving an opinion. Russia is to be reproached for failure to send competent observers of the disease.

The first question is, What is the true determinant of the malady? No one would hesitate to say that the *buboes*, or swellings of the lymphatic glands, take the first place. But it is still doubtful whether or not certain acute forms occur without glandular tumour. (It is not merely the exterior glands that are referred to.) Typhoid fever, the most nearly related disease, is, of course, always (except in children) marked by a peculiar affection of the glands.

The pestilential bubo, like the alterations characterising many of our indigenous infectious diseases, consists in a cellular hypertrophy, with more or less hyperæmia and hæmorrhage. We come again to an obscure point in asking, how does a bubo of this kind ulcerate? The ulcerations in typhoid fever show suppuration, *within the glandular tissue*, round a dry mortified centre. Accounts by some of the best observers of pestilential bubo affirm suppuration *round the gland*. But the chief point is, what is the prime cause of the suppuration? And here I cannot affirm that the abscess of the gland arises from mortification of the gland. Some observers speak only of a softening of the substance. If partial mortification induced the ulcerations distinguishing plague, as they do those of typhoid fever, the analogy between the two diseases would be more marked.

Though we do not really know whether glandular affections are, from the outset, an essential character of the disease, they yet present the essential criteria for diagnosis of the plague.

[Prof. Virchow proceeds to object to Hirsch's view regarding the Indian Plague of Pali, in 1838, which showed peculiar symptoms, as a particular species of plague. Either it was the plague or it was not the plague. If the malady of Astrakan were a peculiar Indian plague we should not be warranted in identifying it with the well-known plague of the Levant, for this alone is the true plague. Hæmorrhage of the urinary organs (as in the plague of Pali) is very common even in the Oriental plague; but he would not therefore create a special hæmaturic species of the plague, but say that hæmaturia is often a symptom of the plague. He does not now refer either to this plague of Pali nor to a known endemic plague, restricted to two districts of the Himalayas.]

Another special character of Oriental plague is carbuncle; it occurs in nearly a fifth of the cases; the symptoms are like those of ordinary contagious carbuncle. There is no sufficient evidence of carbuncle in internal organs. Then there are the petechiæ, or spots, and interior hæmorrhages. Tumour of the spleen seems very constant, and of great importance, and we find also tumefaction of the liver and kidneys. The swellings of the glands, the carbuncles, and the petechiæ are the most important symptoms.

At the beginning of most pestilential epidemics a Committee of doctors has generally declared that it was not the plague. They pronounced it petechial typhus. This was the case immediately before the outbreak of the plague at Rescht, when the disease had been long confined in Kurdistan and Mesopotamia. M. Tholozan was the first to say it was plague, and that the case was that, not of a great epidemic, but of a latent disease, spreading slowly and attacking only a few. It is indubitable that we have there a true centre, whence the disease gradually spread, and I do not see why we should go to India, where the disease has not prevailed for many years past. Proceeding logically, we shall accept this course: From Kurdistan and Mesopotamia to Persia and on to beyond the Caspian. Even if the present cases on the other side of the Caspian were accompanied by pneumorrhagia, I would not hesitate to say they belonged to the plague proper, and that the disease is the same as that in Mesopotamia. The symptoms are very different from those of petechial typhus, the disease which the Turkish doctors affirmed. If near Salonichi (Xanthi) there be really petechial typhus accompanied by *Metastasis bubonica*, I fear it is the plague. It remains to keep our eyes open and see what happens after the return of the Russian army from the infected country (an occurrence which may well rouse grave apprehensions).

What has been done for our protection is little apt to tranquillise us. A blockade comprising all the frontier as well as the coast, from the Baltic to the Black Sea, seems to me illusory.

One example of severe quarantine has occurred in this century in the case of the plague at Noja, in Bari (Kingdom of Naples), in 1815. Trenches were dug, and three cordons of sentinels were formed (the third round the entire province), with orders to kill whoever tried to break the blockade and did not stop at the first summons; and some individuals were actually killed. But I cannot think an entire country is able to protect itself thus. Examination of passports would be excellent if those who deliver passports and certificates of health were angels. But the Russian functionaries are men, and think like men. The impossibility of always getting true certificates of origin has been seen in the case of the cattle plague. I consider, however, that pressure should be exerted on Russia to form a blockade of the infected districts. And especially it should be seen to, that the returning Russian army does not bring any pestilential germs with it. As to restrictions on communications by land, the greatest of these are ineffectual for the end desired.

I cannot give an opinion as to whether the matters which are now forbidden to be imported into the German Empire may propagate the plague. The negative does not seem to suffice. We know that the skin or hair of an ox affected with carbuncle may engender contagion after several months in distant countries; we should not forget this, and we have not the right to say that garments, linen, bedclothes, &c., are perfectly innocuous.

A word on two points relative to disinfection. On Prof. Pettenkofer's advice, the German empire has decided for sulphurous acid as a means of disinfection. I question if this substance would penetrate linen, clothes, wool, &c., in such a complete way as to annihilate all germs. In my opinion a better plan is disinfection of clothing, &c., by dry heat in a chamber surrounded by steam-pipes, the temperature being raised to 120° C. or more. This plan is more rational and easy, and damages the objects least.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

In the Cambridge Senate, last Saturday, Mr. Balfour, a recent examiner in the Natural Science "Specials" for the B.A. degree, spoke of the schedule for botany, to which we referred recently, as extremely unsatisfactory and incomplete; histology was altogether neglected, physiology was very unsatisfactorily dealt with, and cryptogamic botany was almost entirely omitted. He was in favour of an examination in elementary biology being substituted, and practical work being required. Physiology should be made a separate subject. Prof. Humphry spoke in favour of reducing requirements in schedules to the narrowest range, in order to make natural science attractive to men. Mr. Trotter thought the schedule in botany an absurdly small representative of a year's work for a man supposed to have no other definite study. Mr. Bettany found fault with the present constitution of the Board of Natural Science Studies, which dealt with too many subjects, each being insufficiently represented by men engaged in teaching and research. No doubt it is hard for many to realise that biology has very many distinctive aspects, each of which must be represented by proficiency in them to prevent injustice and injury to scientific progress. Hindrances also arise from the fact that many of our present leaders and directors of study were developed before the full recognition of cell-study, embryology, and the like, as the basis of sound biology.

Dr. Alexander Dixon, Professor in the University of Glasgow, has been elected to the Professorship of Botany in the University of Edinburgh, vacant by the resignation of Dr. Balfour.

SCIENTIFIC SERIALS

The *Archives des Sciences Physiques et Naturelles* (February, 1879), contain the following papers of interest:—On the hydrocarbons obtained through the action of methyl-chloride upon benzole in the presence of ammonium chloride, by MM. E. Ador and A. Rillet.—On the theory of *timbre* and particularly on that of vowels, by Dr. Schneebeli.—On the scientific principles of the fine arts; essays and fragments on the theory, by E. Brucke, followed by remarks on optics and painting, by H. Helmholtz. —On some rare mosses, by J. E. Duby.—Stratigraphical study of the south-western part of the Crimea, by E. Favre.—Natural history of batrachia, by Fr. K. Knauer.—On a ogamic ferns and on apogamy generally, by Prof. A. de Bary.—On the prolification of the fruit of mosses, by Dr. N. Pringsheim.—On polyembryony, by Dr. Ed. Strasburger.

The *Journal de Physique* (March) contains the following more important papers:—On spectroscopes with direct vision and great dispersion, by M. Thollon.—On the logograph, by M. Barlow.—On a new phenomenon of static electricity, by M. E. Duter.—Note on spectrophotometers, by M. A. Crova.—On the vibratory motion generated in the air and in space by electric sparks, by E. Mach.—On the electricity of air, by Rob. Nahrwold.

SOCIETIES AND ACADEMIES

London

Royal Society, March 13.—"On the Influence of Coal-dust in Colliery Explosions." No. 2. By W. Galloway. Communicated by Robert H. Scott, F.R.S., Secretary to the Council of the Meteorological Office.

The first experiment is made with a very simple apparatus consisting of a continuous pipe about 18″ in diameter, which conducts a small portion of the return air from the point at which it is ejected into the atmosphere by the ventilating fan, to a convenient spot on the level of the surface, where it escapes as a strong current, amounting to 1,251 cubic feet per minute. About 6 feet from its point of exit a lamp can be placed in the centre of the current, and at a distance of about a foot still nearer the origin there is a means of allowing coal-dust to fall into and mix with the passing air. It is found that when the coal-dust is added the air becomes instantly inflammable, showing that all the return air in the workings may be easily brought into the same condition by a sudden disturbance such as that caused by a local explosion of fire-damp.

The second experiment is intended to illustrate the effects of an explosion of fire-damp in a dry mine containing coal-dust. One part of the apparatus represents a gallery with coal-dust lying on its floor as well as in the horizontal timbers, the buildings and other rough surfaces at its top and sides; another part represents a cavity in the roof containing an explosive mixture of fire-damp and air. When the explosive gas is ignited the flame sweeps down into the gallery, the disturbance raises the coal-dust, and the results are exactly those that have been foreseen. The gallery is a wooden pipe 14 inches square inside, by $79\frac{1}{2}$ feet long. The explosion-chamber is a sheet-iron cylinder lined with thin wooden laths; it is 5 feet high by 15 inches in diameter, and it stands vertically on the top of the gallery at a distance of 5 feet from one end. Currents of air of different quality can be made to pass along the gallery from the end next the explosion-chamber, which can be isolated by means of a valve, to the other end which is open to the atmosphere; thus the return air of the mine can be made to traverse it, or a current of pure air, or a current of air mixed with any required proportion of fire-damp. At the point where they enter the gallery these air-currents are heated by a steam cylinder, which occupies part of the space between the explosion-chamber and the nearer end, so as to assimilate their temperature to that of the air in a mine. The coal-dust is spread along the floor of the gallery, and some is laid on shelves so that it may more easily mix with the air when it is disturbed.

The explosive mixture is made by admitting about half a cubic foot of fire-damp into the explosion-chamber at its upper end, while a corresponding quantity of air is allowed to escape through a plug-hole at its lower end. The bottom of the explosion-chamber is separated from the gallery by a diaphragm of paper during this part of the operation. After the requisite quantity of fire-damp has been admitted, its volume having been accurately measured so as to guarantee that the results will always be the same, the mixture is effected by rapidly revolving a small fan, situated at the top of the explosion-chamber, and so constructed as to draw in air from the centre of the chamber, and throw it out at the circumference. From the point at which the fan draws in its air a 4-inch pipe descends to near the bottom of the explosion-chamber, and when the fan is revolved the air is drawn up through this pipe and discharged at the top of the chamber, from which it finds its way again to the bottom, and so on. The circulation established in this way is so rapid that a perfect mixture can be made in half a minute. The explosive mixture is ignited by means of a spark from a powerful magneto-electric machine.

When there is no coal-dust in the gallery the flame of the fire-damp explosion does not extend further than from 7 to 9 feet from the bottom of the explosion-chamber.

When the gallery contains coal-dust, on the other hand, on the floor and on the shelves referred to, and when it is filled with the return air of the mine the explosion traverses its whole length, and shoots out into the air to distances varying from 4 to 15 feet. The flame of the fire-damp explosion is thus magnified ten times by the presence of the coal-dust and the return air.

When pure air is employed instead of return air, other things remaining the same, the explosion is only about one-half as extensive; and when an artificial mixture of air and fire-damp is employed, of the same composition as the return air, without its excess of moisture, the explosion is stronger than with the return air. The arrangements whereby pure air and air and fire-damp can be used have only been recently completed, and few experiments have been made with them as yet.

Although the apparatus employed in this experiment appears to be on too small a scale to solve the coal-dust question unequivocally, the results obtained with it appear to be sufficiently conclusive to enable us to affirm that an explosion, occurring in a dry mine, is liable to be indefinitely extended by the mixture of air and coal-dust, produced by the disturbance which it initiates.

The only means of avoiding the dangers due to the presence of coal-dust in mines appears to be to carefully and constantly water the roadways leading to and from the working-places.

It is very interesting to be able to mention a fact in connection with watering the roadways which, although not mentioned in Mr. Galloway's paper, is well worthy of a place here, viz., that the Abercarne explosion, ramified through every part of the workings, which were exceedingly dry and dusty, with the exception of one district from which it was entirely cut off by 200 yards of a very wet roadway, and that the men in the latter district not only escaped unhurt, but hardly felt the explosion. The wetness of this roadway was due to natural causes.

April 3.—"On the Thermal Conductivity of Water," by J. T. Bottomley, Lecturer in Natural Philosophy and Demonstrator in Experimental Physics in the University of Glasgow. Communicated by Prof. Sir William Thomson, LL.D., F.R.S.

The result arrived at by the experiments described, is that the thermal conductivity of water may be taken at from ·0022 to ·00245 in square centimetres per second.

Some experiments have been made on the thermal conductivity of solution of sulphate of zinc, a solution which happened to be convenient for preliminary trials. The specific heat of solution of sulphate of zinc at different densities, which it is necessary to know for comparison as to thermal conductivity of that liquid with water, has been determined.

Experiments are now being carried on on this subject with the assistance of a grant from the Government Fund of 4,000*l*.

Anthropological Institute, March 25.—Mr. E. B. Tylor, D.C.L., F.R.S., president, in the chair.—Mr. Henry Seebohm, F.Z.S., gave some interesting particulars respecting the native races of Arctic Siberia, accompanied by an exhibition of ethnological objects collected in that region. In 1874 he visited Lapland, of which he gave some account, and in the following year he proceeded from St. Petersburg to Archangel, and thence 600 miles eastward, where he first came in contact with the Samoeïdes, and obtained some particulars about the Voguls, who dwelt across the Ural range. But his most adventurous journey was in 1877, when he accompanied Capt. Wiggins on his expedition for the exploration of Arctic Siberia. After travelling 2,500 miles from London to Nishni-Novogorod, they took sledge thence, and pushed on 3,500 miles farther, until they reached the Arctic Circle. In the Tartar villages there which they visited they found that the crescent predominated over the cross, and what still more surprised them, it seemed to be the symbol of a superior civilisation and order. The native languages were akin to the Turkish. The copper-coloured Buriats, who dwelt behind the Baikal Mountains, were a somewhat different race, and bore a strong resemblance to the Chinese. The Ostiaks and Dolgans were located on the colossal river Yenisei, which was reckoned the third largest river on the face of the globe. The Tungoosks were settled on one of its chief tributaries. The costumes, weapons, tools, smoking-appliances, reindeer-harness, snow-shoes, snow-goggles, idols, &c., of these and kindred tribes were shown, together with a remarkable case of prehistoric bronzes, found in ancient Siberian graves, and thought to be from 4,000 to 5,000 years old.—A paper was read by Sir Charles Nicholson, Bart., D.C.L., LL.D., on some rock carvings found near Sydney, New South Wales. Rude carvings of human and other animal forms, especially kangaroos and fishes, including the whale, had been found at various points of the coast of New Holland, from Cape Howe to Moreton Bay. The present natives had no tradition as to their origin, yet there were no good grounds for refusing to regard them as works of indigenous art. Col. Vigors had copied many of them, and a number of his drawings were handed round. One of these carvings represented a wall thirty feet long. Those found in Sydney cavern included a kangaroo at bay and a man erect, with out-stretched arms. Another class of similar carvings were chromatic. They were found on the north-west coast, and had been plausibly supposed to be the work of Malay pearl-fishers or shipwrecked sailors.

Zoological Society, April 1.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—An extract was read from a letter addressed to the Secretary by Mr. Carl Bock, respecting the habits of the Mountain Antelope of Sumatra (*Capricornis sumatrensis*), of which he had obtained a living specimen destined for the Society's collection.—Mr. J. W. Clark exhibited and made remarks on a drawing of a Dolphin belonging to the genus *Lagenarhynchus*, which had been lately taken off Ramsgate.—Prof. Flower exhibited a coloured drawing of a young female of the common Dolphin (*Delphinus delphi*) lately taken off the coast of Cornwall, and made some observations on the published figures and geographical distribution of the species.—The birds' eggs collected during the *Challenger* Expedition were exhibited. The series was stated to contain about 250 eggs belonging to fifty different species. Amongst these were eggs of the Sheathbill (*Chionis minor*) from Kerguelen, and of the Wandering Albatross (*Diomedea exulans*), from Marion Island.—Prof. Mivart exhibited a figure of and made remarks upon a Kestrel with abnormal feet, in the collection of the Marquis de Wavrin, at Brussels.—Mr. R. Bowdler Sharpe, F.Z.S., read an account of the collection of birds made by Mr. F. W. Burbidge, in the Sooloo Islands. A new Jungle Fowl was described as *Gallus stramineicollis*, and a new Parrot as *Tanygnathus burbidgii*.—A second communication from Mr. Bowdler Sharpe, consisted of a list of the birds of Labuan Island and its dependencies, founded principally on the collections formed during the last four years, by Governor Ussher and Mr. W. H. Treacher, but including also descriptions of a large number of eggs carefully collected by Mr. Hugh Low. One new species, *Cypselus lowi*, was described.—A communication was read from Mr. R. Collett, C.M.Z.S., containing the description of a new fish of the genus *Lycodes*, from the Pacific, which he proposed to call *Lycodes pacificus*.—A communication was read from Prof. Garrod, F.R.S., containing an account of the variations in the trachea and tracheal muscles in the different forms of gallinaceous birds.

Institution of Civil Engineers, March 25.—Mr. Bateman, president, in the chair.—The paper read was on the electric light applied to lighthouse illumination, by Mr. J. N. Douglas, M. Inst. C.E. The author showed the progress of lighthouse luminaries from wood and coal fires to the introduction of tallow candles, fatty oils, mineral oils, coal gas, and electricity.

Statistical Society, March 18.—The president, G. J. Shaw Lefevre, M.P., occupied the chair.—Mr. H. H. Hayter, the Government Statist of Victoria, read a paper on the colony of Victoria; its progress and present position.—The following were elected as Honorary Members:—M. le Dr. E. Janssens, of Brussels, M. Arthur Chervin, of Paris, Signor Gerolamo Boccardo, of Genoa, and Prof. Dr. Fr. Xav. von Neumann-Sfallast, of Vienna.

Victoria (Philosophical) Institute, April 7.—Two papers were read, one by Thomas Karr Callard, F.G.S., and one, taking some special points, by Prof. Boyd Dawkins, F.R.S. The subject was the contemporaneity of man with the extinct mammalia (as taught by recent cavern exploration), and its bearing upon the question of man's antiquity. The first paper contended that the cavern evidence points to the more recent extinction of the mammalia referred to, rather than to the remote existence of man.

BOSTON, U.S.A.

American Academy of Arts and Sciences, March 12.—Prof. W. A. Rogers presented a paper on the coefficient of expansion of the brass bars used by the U.S. Coast Survey for standards of length. In order to compare different standards it was found necessary to determine the coefficients of expansion of the particular bars on which the graduations were made. In the present case the coefficient was found to be ·0000097 by a process extremely simple and effective. The relations between water and air contact also seem to be well determined by this method of investigation.—Dr. J. J. Putnam showed a *pendulum myograph*, modified mainly for the sake of economy, from that of Wundt. The pendulum itself is made of the thickest plate-glass, and arranged so as to be moved up and down, with the aid of a racket and a counterpoise, together with the stage bearing the movable connections described by Wundt. Since for each position of the pendulum a tracing of given length would have a different significance from that in any other position, enameled cards were prepared with lines upon them diverging from the point of suspension, the intervals between which corresponded to ·01″ when the amplitude of swing was 20°. By means of this apparatus the *reliability of Marey's tambour* had been tested, with a view to its use in time-experiments in physiology. The delay for the tambour used, with a tube about 2 m. long, was found to be nearly ·01″, varying not more than ·002″ to ·003″ under impulses of different character and strength.

GENEVA

Society of Physics and Natural History, December 19, 1878.—M. God. Lunel spoke of the variations of colour presented by the squirrel, and cited some cases of albinism of that animal in a special locality of the Valais.—Prof. Brun described observations of the phenomenon known as "rain of blood," made by him on May 14 last, on the Jebel Sekra, a summit of the Rist, at the western extremity of the Atlas, in Morocco. He observed it in the form of spots of a very bright red appearing in the rocks, and one to a mixture of siliceous sand and very fine lime, with abundance of unicellular algæ of the species *Protococcus fluvialis*, and containing especially peroxide of iron.—M. Wm. Barbey informed the Society of the gift recently made by Sir J. Hooker to the Museum of Lausanne of the herbarium of the botanist Gaudin of Nyon.

January 2, 1879.—Prof. Graebe made a communication on the discovery of alizarine in the various colouring matters extracted from it, and particularly on alizarine allies.—M. Alph. de Candolle gave an account of the number of specimens contained in his herbarium, commenced by his father in 1798. At the time of the death of the latter in 1841, the herbarium contained 161,748 specimens; now it contains 287,636 belonging to 80,000 or 90,000 vegetable species.

PARIS

Academy of Sciences, March 31.—M. Daubrée in the chair.—The following papers were read:—Conformity of the systems of fractures obtained experimentally with the systems of joints which traverse the cliffs of Normandy, by M. Daubrée. These joints form two systems, and the general effect is like that produced in a plate by weak torsion.—Convenience of special denominations for different orders of fractures of the earth's crust, by M. Daubrée. He proposes the name *diaclase* for a fissure produced by rupture; *paraclase*, to express that the fracture is accompanied by displacement; and *lithoclase*, as a general term including the two large groups now specified.—New process for the gauging of rivers, by M. Boileau. This process is based on the property of water-courses, that at the surface there are two streams whose velocity of translation is equal to the mean velocity of the current. The hydrometric operations are reduced to use of a float.—On the last floods of the Seine, by MM. Lalanne and Lemoine. Last winter was marked by two successive floods reaching (at a short interval) very nearly the same high level (6·21 m. at the Pont Royal on January 8 and 6·05 m. on February 24). Since 1872 M. Lemoine has organised, under M. Belgrand's direction, a system of warnings of flood (three days previous) for the Seine and its larger affluents. They are sent by telegraph or otherwise to seventy four persons in Paris and sixty-seven outside of Paris, and have proved very correct.—On some observations of glazed frost similar to that of January last, and on the mode of formation of hail, by M. Colladon. In large hail-storms, the cumuli producing them are divided into several distinct groups, insulated electrically from each other by sections of dry and cold air, resembling smoke-columns from several chimneys. The columns of hail the author conceives as a huge descending piston; hence the violent whirling movements of wind near the ground, and the descent of cold, dry, highly electrified air from the upper regions, to restore equilibrium; this air divides the clouds into nearly vertical columns; hence the peculiar forms of lightning during those storms.—M. Du Moncel presented a work entitled "L'Eclairage Electrique."—Prof. Lawrence Smith was elected Correspondent in Mineralogy in room of the late Sir Charles Lyell.—Chemical researches on a filamentous matter found in the excavations of Pompeii, by M. de Luca. The substance (which seemed formed of numerous filaments) was black and almost completely carbonised; on simple pressure with the fingers it was reduced to powder. The threads seem to have been flax or hemp, altered by various natural agents underground during eighteen centuries.—On the cost of constructing lightning-conductors, by M. Melsens. His system applied to the large new barracks at Etterbeck-laz-Bruxelles, on buildings occupying 20,000 square metres, will be less than 6,000 francs.—Observations of Planet 193, discovered at Marseilles Observatory, by M. Coggia, February 28, 1879, communicated by M. Stephan.—On two equations with partial derivatives relative to the multiplication of the argument in elliptic functions, by M. Halphen.—On cylindric or logarithmic potential with three variables and its employment in the theory of equilibrium of elasticity, by M. Boussinesq.—Anomaly presented by magnetic observations of Paris, by M. Flammarion. Since 1870-71 the last maximum of sun-spots and of diurnal variation of the declination-needle, the amplitude of this variation has decreased everywhere except at Paris; here it seems stationary; and even the year 1877, which should approach a minimum, presents a maximum. Some like anomalies are observable in previous times.—On the thermal and galvanometric laws of the electric spark produced in gas, by M. Villari. *En résumé*, the thermal and galvanometric deflections produced, the former by the spark, the latter by the discharge of a condenser, are proportional to the quantity of electricity which produces them, and to the length of their active circuits.—Magnetic rotatory power of gases at ordinary temperature and pressure, by M. Becquerel. With improved apparatus he has not only got the rotation-effect but been able to measure it with precision. He gives results for coal-gas, &c.—On the magnetic rotatory power of vapours, by M. Bichat. The experiments were like the Strasburg ones, but with a brass instead of an iron tube (which is objected to as forming a hollow electromagnet).—Pressure exerted by galvanic deposits, by M. Bouty. A cylindrical thermometer bulb covered with gold leaf or silver is made negative electrode in decomposition, *e.g.*, of a salt of copper; the rise of mercury when deposit occurs is noted. All metals, zinc included, exert pressure thus; but the pressure is not necessarily normal nor the same at all points, and cannot serve directly as a measure of the phenomenon; it is the result of a change of volume of the metal in deposition.—On the alkalies of pomegranate, by M. Tauret.—On the formation of carbonic acid, alcohol, and acetic acid by yeast alone, without oxygen, and under influence of this gas, by M. Bechamp.—On glazed frost observed in Florida, by Mr. Collin.

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