THURSDAY, JANUARY 13, 1876

OUR WATER SUPPLY

THE last Report of the Commissioners appointed to inquire into the Pollution of Rivers has excited a considerable amount of public attention, and the press, in addition to giving its own views on the matters reported on, has printed a considerable number of letters from private persons interested in the question. We have, of course, had the usual remarks about the conflicting statements of scientific witnesses, and a large quantity of ingenuity has been expended in attempts to prove that this conflicting evidence is an indication of the witnesses being so wedded to pet theories that they are unable or unwilling to see facts in their true light, and hence that the best way is to let matters take their course and trust that everything will come right in the end. To a very large portion of the world this conclusion is a most comfortable one to arrive at, as it spares the ratepayer and offers no offence to the dreaded "vested interest." On the other hand, there is a considerable section of the public which cannot hear that any part of our institutions is not absolutely perfect without being thrown into a state of nervousness and dread, a section well exemplified on the occasion of a former report by a paper which stated that—"We must face the dreadful fact that no amount of filtration can free our water from the nitrates and nitrites which are amongst the most deadly of poisons!"

No person of ordinary common sense can fail to perceive the folly of the alarmist school, but to the non-scientific public the fallacies of those whose cry is *stare super vias antiquas* are much more difficult to detect. Unfortunately the education through which most of the present generation have gone is not one which can enable them to arrive at any correct judgment as to the value of statements made by one scientific witness as compared with those made by another; the natural result of their education is in fact to cause them to attach a great value to the statements of a man who has a reputation for what is known as "popular science," and to regard the real worker or knower as an amiable enthusiast or eccentric theorist who is so carried away by his fancies that he is quite incompetent to pronounce upon practical matters. The same habit of mind induces them to value the statements of those whom they are pleased to call "practical men," who are generally men having an empiric or imperfect knowledge of certain processes. The result of this is that the opinion of one who has a mere smattering of chemistry, and therefore considers himself qualified to speak on all chemical questions, is pitted against that of one who has devoted his life to chemical and physical science, and the puzzled outsider sits down exclaiming, "Who is to decide when doctors disagree?" Again, this state of things is pretty well known to the people who are put on their trial by the allegations of those appointed to inquire into sanitary affairs, and they know well enough where to lay their hands on those who will make the best of a case entrusted to them; and we cannot help thinking that if it were possible to tabulate the names of the scientific witnesses called during the last ten years on the side of sanitary reform or on the side of those who considered their interests endangered by it, some curious facts would be brought to light.

A letter from Sir Edmund Beckett, in the *Times* of January 10th, illustrates the state of the case remarkably well. The writer, speaking of letters by Mr. Denton and Lord Camperdown, says that if they had heard as much scientific evidence about water purity as he had, one would have been less puzzled and the other less alarmed; and he then goes on to say that—"They would then have known that the late Report is only what every person of experience in hearing such evidence could have predicted with certainty from the constitution of this commission." We may add to this, that any thoroughly competent commission of chemists working with a trustworthy process, could not have arrived at conclusions greatly different from those arrived at by the reporters. The writer then proceeds to say:—

"I have heard eminent scientific men assert on their oaths—and they always add that these things are 'not opinions, but facts'—that the water of a moderate-sized river receiving the unpurified sewage of half a million people was perfectly good, potable water for a town not many miles below the sewage-supplying places. That is a specimen of what we may call the impurist philosopher's view of water.

"On the other hand, there is a school which maintains, with equal positiveness, the theory that no length of run (within such distances as we are practically concerned with) purifies sewage by oxidation, but that a particle of sewage, or whatever other learned name they call it, sent into the Thames at Oxford arrives as a particle of sewage at Hampton, and may poison a man in London. It is true that they do not quite like the proposition reduced to those very bare terms, but they cannot deny, when they are pressed by a little cross-examination, that it is the logical consequence of their theory."

We very much regret that the names of the "eminent scientific men" who make the first assertion have not been given, as we should then have some means of ascertaining the value to be attached to their assertions. With regard to the latter statement we think that the writer to a great extent entirely misses the point. Very few scientific witnesses will maintain that Oxford sewage *at present* reaches Hampton as sewage; the question is, How long will the present state of affairs remain? With our rapidly-increasing population the volume of sewage yearly poured into a river at any one point must increase, as do the number of points at which sewage is poured in; and the questions really asked of the public are—How long do you suppose that this can go on before the river-bed is coated with sewer mud and becomes, as hundreds of streams which a few years back were clear and bright have become, an open sewer? And is it not better to take such measures as shall prevent such a state of things from coming about than to wait until the pollution becomes unbearable?

The writers of the report in question are perfectly well able to fight their own battles, so that we do not think it necessary to enter into any elaborate defence of their suggestions, but we must protest against their being treated as visionaries, and their statements being judged as of no more value than those of the "eminent scientific men" who say that a moderate-sized river can receive the sewage of half a million of people and yet be a "perfectly good, potable water not many miles below the sewage-supplying places."

We are in no danger of the theory of "*sanitas sanitatum omnia sanitas*" being pushed to excess by sanitary zealots; and for the present, at any rate, the teaching of the Rivers Pollution Commissioners has been nothing more than "take care of the sewage, and the water supply will take care of itself."

LIEUT. CAMERON IN CENTRAL AFRICA

THE first detailed news of the latter half of Lieut. Cameron's trans-African expedition was read at the Geographical Society on Monday night, in the form of extracts from letters of the explorer, who intends to remain at Loando until he has a chance of finding a genial climate here. We do not yet possess details sufficient to authorise us in drawing final conclus ions as to the results so far as the great problem of Central African drainage is concerned; though we are quite justified in concluding that Lieut. Cameron has proved himself to be possessed of the qualifications of an explorer of the first rank, and that means ought to be found of making still further use of his valuable services. He has not been able to accomplish all he intended when he set out from Ujiji in March 1874, but he has certainly added very largely to our accurate knowledge of Central Africa. He was not able, owing to the hostility of the natives, and the want of pluck in his followers, to follow the course of the Lualaba in order to ascertain whether or not it joins the Congo. He has, however, obtained data which render it very improbable that the Lualaba and Tanganyika contribute to the Nile system; the only known outlet of the lake, the Lukuga, he has ascertained, flows into the Lualaba. This latter river at Nyangwè is only 1,400 feet above the sea, or 500 feet below the Nile at Gondokoro, and lies in the centre of an enormously wide valley, "which receives the drainage of all this part of Africa, and is the continuation of the valleys of the Luapula and Lualaba." Cameron found that the river, contrary to Livingstone's report, really turns to the west below Nyangwè, and the Arabs report that further down it flows W.S.W. A river, the Lowa, said to be as large as the Lualaba, at Nyangwè, joins it from the northward a short way farther down, besides other important rivers from the same direction. Cameron failed to make his way to Sankorra, a lake into which the Lualaba falls, and to which "trowser-wearing traders are reported to come in large sailing-boats to buy palm-oil and dust (probably gold) packed in quills."

Lieut. Cameron traces with considerable minuteness the course of the Lualaba to some distance below Nyangwè. He shows that the true Lualaba in its upper course is the river to the west of Lake Bangweolo, crossed by the Pombeiros in their trading journeys to Cassembe's Town, and that Livingstone's Upper Lualaba is properly called the Luvwa. The river receives many tributaries during its course to Nyangwè, and passes through a number of lakes, so that by the time it reaches its final destination it must be a river surpassed in volume by few others.

All this seems to indicate that the Lualaba reaches the sea on the west coast, but that it does so by means of the Congo it would at present be unsafe absolutely to assert, though if it do not, what other Central West African river is of sufficient size to carry off the immense drainage which the Lualaba evidently represents?

On account of the vexatious obstacles to his course along the Lualaba, Cameron turned southward, and during his journey south and then west to Benguela he made many valuable and accurate observations which will help greatly in filling up that portion of the map of Africa. Some distance south of Nyangwè he came upon a small lake Mohrya, fed by the rains, and apparently isolated from the rest of the water-system, but which is interesting as containing regular lake-villages. He is inclined to believe that the Albert Nyanza is much smaller than Sir Samuel Baker makes it, and he found that the Lomâmi has no connection with the Kassabè, as shown in the map published by Keith Johnston. In the southward march Cameron passed the sources of the Lulua, which runs into the Zambesi, whose sources he places in 23° E. long. and 11° 15′ S. lat.

Cameron gives the most glowing description of the productiveness of the country through which he has passed; coal was found, gold, copper, iron, and silver are abundant, and he is confident that with a moderate expenditure of capital "one of the greatest systems of inland navigation in the world might be utilised." Multitudes of tropical products abound, and the region is well adapted for the cultivation of extra-tropical ones. A canal, he thinks, of twenty to thirty miles in length, would connect the Congo and Zambesi systems, and the resulting commercial advantages would be enormous. So the enthusiastic traveller believes, and whatever may be the results in this direction, the gains which have accrued to accurate geographical knowledge from his journey are such as must earn him the warmest thanks of the friends of science. He has taken 400 observations, "and consequently," as Sir Henry Rawlinson remarked, "has soundly established all the geographical landmarks of the country."

MORELL'S "EUCLID SIMPLIFIED"

Euclid Simplified. Compiled from the most important French works, approved by the University of Paris and the Minister of Public Instruction. By J. R. Morell, formerly H.M. Inspector of Schools. (London: Henry S. King and Co., 1875.)

EUCLID simplified! "My friend M., with great painstaking, got me to think I understood the first proposition in Euclid, but he gave me over in despair at the second." Had Elia lived in these days of modern geometries perchance he had been a moderate geometer, but his wit might have been dulled. The book before us, however, is not the book we should recommend to a sucking geometer. We look upon it as one of those private ventures which we hope the Association for the Improvement of Geometrical Teaching will extinguish. There is hardly a page without its crop of faults. The title we consider to be a misnomer, for the method of Euclid (the geometer) is departed from altogether. We should look to find in a "Euclid Simplified" something far different from this. The treatise is based upon good geometrical authorities, as will be seen by a reference to the prefatory remarks; it is to the form in which these authorities are presented that we object. Who is the interpreter? A former "H.M. Inspector of Schools." We have been wont to look upon these gentlemen as masters of one or more tongues, and as having a fair acquaintance with the "ologies." We have not formed a high opinion of the geometrical attainments of this compiler, nor do we consider him to be well versed in the French language, or even in elegant English composition. "Quis custodiet ipsos custodes?" It is "a work offered for the use of schools;" it is essential, then, that the writer should take all due precaution to be accurate. We think, further, that he should rather be disposed to retain terms with which boys are fairly acquainted, if they are correct, than to be constantly using terms and phrases which betray their Gallic descent. Thus pp. 23, 55: "angles are equal *as opposed at* the summit;" p. 40: "this corollary *gives occasion to*;" pp. 110, 112: "shows that to *have* point *c*;" p. 141: "operating in the same *measure*" (? way); p. 166: "three points taken in *equal number* on the sides of a triangle and in *unequal number* on its sides produced;" p. 168: the centre of similitude is the *meeting-place*," &c.; we shall get to rendezvous in time. The words "passing *by* a point" (*par*) occur repeatedly; on p. 108 we have "*by* point *D* draw in like maner (*sic*);" pp. 41, 42, furnish "perpendicular to the centre," "perpendicular to the middle," and so on.* It is hardly good English to say one point becomes confounded with another point, pp. 46, 97, 127; the boy-mind is apt to confound the different steps of the reasoning, and the boy often is tempted to exclaim, "Confound it altogether." "Cord" of a circle would not be difficult to make out by one who had read French mathematics, but at a "spelling-bee" we should prefer the candidate who spelled it "chord." But to return to the prefatory remarks. These have no signature, so we cannot be sure that it is Mr. Morell who writes "it is anticipated that it will prove more practically useful than most other school-books on the subject." We should expect, too, some recognition of the work accomplished by the association referred to above, the more so as Mr. Morell was at one time a member of the association. We should have been disposed to think that he has employed some one to make the compilation and translation, and has not carefully revised the work himself; but then against this we have the title-page. Were we to note and comment upon every passage we have marked, we should tire our readers. We shall content ourselves with culling a few elegant extracts. Many of the enunciations are loosely, if not always incorrectly, worded. Parallels are treated of in p. 21 before any definition of them has been given. On p. 24 we are told the term *transversal* is new to English schools: "it explains itself," and we are favoured with its derivation; in like manner, on p. 73 we are informed that *harmonics* have been "recently introduced in French geometry;" in the same note a specimen is given of "the new and interesting treatment of this question (*i.e.* harmonics) abroad;" on p. 72 we have a note on the word *capable*; "this term—used in French treatises—explains itself, if traced to its Latin root, *capax*, holding, a segment capable of an angle = a segment holding an angle." And on p. 104: "this circumference, by the well-known construction of the capable angle, will pass by point *B*."

A parallelogram is defined to be a quadrilateral, of which the opposite sides are *equal*; in theorem xxxi. he subsequently proves this. The term *lozenge* is used in the text, and a note tells us that the figure is called "*rhombus* in the old-fashioned Euclid." A terrible mess is made of *circumference* on p. 36. "*The* circumference is a plane line, of which all the points are equally distant from one same point situated in the middle and named centre." This is not so bad as the common school-boy definition: "a circle is a plain figure bounded by one straight line, and is such that all straight lines drawn from a certain point in its centre to the circumference are equal;" but it is not what we should expect in a text-book for boys. Again, "a circumference is generally described in language by one of its radii." The italicised *the* is easily accounted for when we remember the source from whence the definition is taken; here, of course, it ought to be *a*, but on p. 51 we ought to have *the* for *a* ("A polygon is inscribed in a circle when its summits are situated on the circumference). Reciprocally (Mr. Morell's term for the usual conversely), *a* circle is said to be circumscribed round *a* polygon," that is, the circle and polygon previously mentioned, otherwise the definition is incomplete. No distinction is made of *major* and *minor* arcs. Thus, p. 39: "of two unequal arcs the greater is subtended by the greater chord;" this is, of course, only true of minor arcs. On p. 66 he bisects a given arc without having shown how to bisect a given line. On p. 70 *C*, *C'* have been wrongly printed in three places. On p. 81 homologous is derived from ὁμοίος and λόγος (p. 9, isosceles from ἴσος is doubtless an oversight). On p. 85 occurs a passage we cannot understand; he has a quadrilateral *A B C D*, and then draws *E F* (*E* on *A B*, *F* on *C D*) parallel to *B C*; he says rightly the angles of the two figures are equal, but the sides not in the same proportion; then he proceeds to say "in like manner, without changing the four sides *A B*, *B C*, *C D*, (*sic*), point *B* can be brought near or removed from *D*, without changing the angles." We cannot understand it, and so do not see it.

In the first note on p. 91, boys are informed that M. Chasles is "Professor of Superior Geometry at the Collége de France, and one of the first geometers of the present age;" in the second, "homothetie" is derived from ὅμοιος and θέσις; in the third, "radiivectors or vectores are the straight lines drawn from the two foci of an ellipse to any one point of the circumference of an ellipse." On p. 122 we are told that the ratio of the equilateral triangle inscribed in a circle to the radius is $\sqrt{3}$, whereas it ought to be (as is proved in the text) the ratio of the side of the equilateral triangle, &c. On this page, and also elsewhere, we have *R* used for a right angle; this is, we think, likely to mislead boys: nor do we approve of the expression, "each of these angles will be *worth* $\frac{2}{5}$ *R*." *R* is usually employed to denote the radius of the circumscribing circle of a triangle. Pages 132, 133, bristle with blunders, due partly to the editor, but principally to the printer. On p. 134, for "pentagon" read "pentedecagon" (a purism for "quindecagon"). Page 136, on the calculation of the ratio of the circumference to the diameter, we read: "The complete solution of this problem belongs to superior mathematics. Therefore it is here less aimed at giving a method to calculate this ratio than to give a notion that it is possible to do so." This last sentence strikes us as not

* For pp. 11, 20, "two triangles are equal *as having* an equal angle,' &c., we should prefer "*because* they have," &c.

being particularly elegant. On pp. 144, 145, in the proof of the important proposition that the ratio of any two rectangles R and R' is the same as that of the product of the height and base of the first, to the product of the height and base of the second, there are two, at any rate typographical, errors which would exceedingly trouble boys or the ordinary run of self-taught students. Also in a numerical example to this proposition the writer correctly gets $\frac{R}{R'} = 4\frac{1}{2}$, and then says the first rectangle is $4\frac{1}{2}$ times *greater than* the second rectangle. On p. 148 the reasoning in theorem vi. is defective, and in the scholium there is a misprint; it is, however, not necessary to dwell fully on this Book V., which is especially faulty. We shall close our remarks on the text by quoting a sentence on p. 171, simply remarking that we could have extended our criticism to twice or thrice the dimensions of the present notice. The sentence is: "The further development of the Theory of Transversals is reserved for a special treatise on Modern Geometry, with a popular view of the recent improvements introduced by M. Chasles." May it be reserved to the Greek Calends! say we. Who and what is Mr. J. R. Morell, that he should venture to act as interpreter of M. Chasles' brilliant contributions to Geometry? Such a work brought out by a competent writer would be of great use. It was in 1871, that Mr. Morell published "The Essentials of Geometry, Plane and Solid, as taught in French and German Schools, with Shorter Demonstrations than in Euclid," &c. After the reception this little work met with one would have hoped that the author would have learnt wisdom, and before he sent forth another such work into the world would have submitted it to one or two candid and competent geometrical friends. The book might yet be made a very fair one, but as it is at present we must condemn it most strongly.

There is an appendix of 205 exercises, and we have marked upwards of forty as each containing something objectionable in language or in geometry. We must content ourselves with a selection:—30. Given a rectangle and a point *situated in the interior of a quadrilateral;* it should be "and a point within it" (or some such words; it is the billiard-table question which is given in many French text-books). 40. A triangle and any plane figure, *in general movable in a plane*, &c. 42. *Which* is the geometrical *locus*, &c. 103. A question of two concentric circles: in the *great* circle, in the *little* one. 116 is not neatly put; it is, "What is the geometrical *locus* of the centres of the circles which intersect *orthogonally*—that is, forming a right angle—two given circles?" 143, 193, he uses *in the function*, where an ordinary geometer would write *in terms of*. *In such wise* and *in* (for "into") frequently occur. Before closing our article, we must point out that the work we have examined is not to be *confounded* with "The Elements of Geometry in Eight Books; or, First Step in Applied Logic," by L. J. V. Gerard, which forms a volume in Dr. J. D. Morell's Advanced Series for Colleges and Schools. This is the work of an able and judicious writer; we must at present content ourselves with merely commending it to the notice of any of our readers interested in the subject. A word of praise we can extend to the external aspect of "Euclid Simplified;" it has a neat and geometrical design on the cover.

TISSANDIER'S PHOTOGRAPHY

A History and Handbook of Photography. Translated from the French of Gaston Tissandier. Edited by J. Thomson, F.R.G.S. (London: Sampson Low and Co., 1876.)

ALTHOUGH one may reasonably object to the statement made by an eminent French *savant* that "chemistry is a French science," there is no denying the fact that photography, so far as its early history is concerned, is eminently a French art. M. Tissandier, the author of the work now before us, of course does not fail to impress this fact repeatedly upon his readers by speaking of photography as the "art of Daguerre," and indeed throughout the book he places his own countrymen in positions which might in some cases be justly considered as somewhat too prominent. The addition of some few historical notes, however, by Mr. Thomson, the editor, renders the work, on the whole, as fair a history of the subject as we could wish to read.

Of the three parts into which the book is divided the first is entirely historical, commencing with a description of the camera obscura of Porta, and the discovery of "Luna Cornea" by Fabricius, and then proceeding to the early experiments of Prof. Charles, Wedgwood, Davy, and Watt. The connection of Daguerre with the first development of photography is of course known to all. The early life of Daguerre forms the subject of the second chapter, and the author here relates an incident which may be new to many of our readers.

It seems that in 1825 a poorly-dressed young man entered the shop of Charles Chevallier, which was at that time much frequented by amateurs, and demanded the price of one of the new cameras with converging meniscus lenses, which were then being made for the first time. The young man's manner showed that the price named was far above his means, and Chevallier then inquired for what purpose he required the camera. The stranger declared that he had succeeded in fixing the image of the camera on paper, but that the instrument he had employed was of rough construction, and he was anxious to continue his experiments with the improved apparatus. Chevallier being sceptical as to this statement, the young man placed on the counter before him a piece of paper, on which appeared a view of Paris, and on further questioning gave the optician a vial of blackish fluid, which he stated to be the liquid with which he operated. To continue, in the author's own words:—"The unknown explained to the optician how he should go to work; then he retired lamenting his hard fate, which would not permit him to possess that object of his dreams, a new camera! He promised to return, but disappeared for ever." It may be added that Chevallier could get no result with the liquid left with him. The incident was related to Daguerre, but the unknown inventor never appeared again, so that his name and fate remain a mystery. The succeeding chapters contain an account of the life and labours of Nicephore Niepce, and a history of the partnership entered into between this gentleman and M. Daguerre. Niepce's process, it will be remembered, depended upon the fact that "Bitumen of Judæa," when exposed to light, becomes insoluble in oil of lavender. Daguerre, continuing his researches under the new act of partnership, at length discovered (accidentally, according to the present account) the action of light upon a film of silver iodide. "Photography was henceforth a fact"—unfortunately, however, at this time his partner died, and Daguerre was left to continue his work alone.

The history and progress of the new art of Daguerreotype is then traced, its purchase by the Government described, and the discovery of accelerating and fixing agents gone into. The editor at this stage reminds us that the use of sodium hyposulphite was first made known by Sir John Herschel, but Mr. Thomson erroneously terms this salt a "developing agent." We next arrive at that period of the history when the improvement in lenses effected by Chevallier enabled the time of exposure necessary for a Daguerreotype plate to be reduced, but even then the sitter had to remain motionless for four or five minutes in full sunshine! The torments of the unfortunate patient undergoing this ordeal are very graphically described. The name of Fox Talbot, who had succeeded in fixing the photographic image on paper some years before Daguerre's discovery was made known, does not appear till rather late in this history,

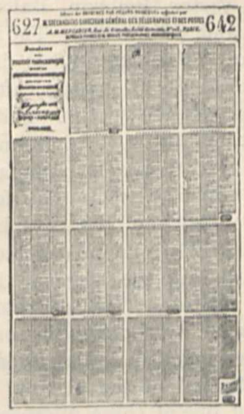


FIG. 1.—Facsimile of a microscopic despatch used during the siege of Paris.

and then in a position which we cannot but consider as too subordinate, to which effect the editor has added a note.

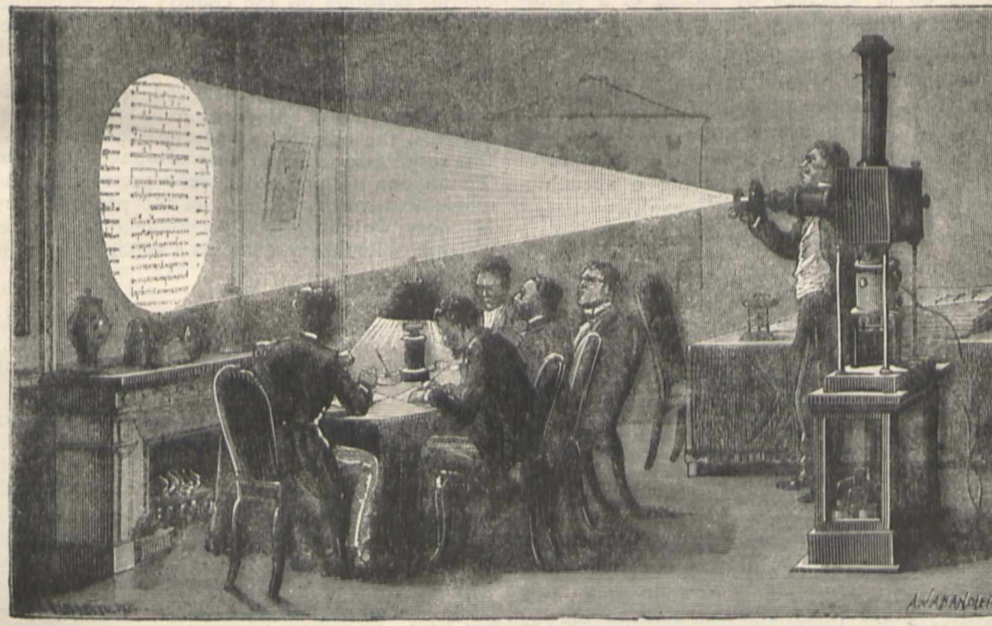


FIG. 2.—Enlarging microscopic despatches during the siege of Paris.

The next stage of photographic history brings us to the time of Niepce de Saint-Victor (nephew of the Niepce who was in partnership with Daguerre), who first discovered the albumen on glass process. The application of collodion to photography by Legray in France, and Scott Archer in England, brings the art down to its present state of development, and the author at this stage brings the historical portion of the subject to a conclusion.

In the second part of the work the operations and processes of photography are dealt with in seven chapters. The watchful vigilance which the editor has kept over the interests of British science has here for once failed. The whole credit of the bichromate of potash and gelatine process—the foundation of all the photographic permanent printing processes—is more than once in the course of the work assigned to Poitevin. "The various processes or producing positive carbon prints," writes M. Tissandier on p. 162, "are based on the principle indicated by Alphonse Poitevin in 1855." We must remind our readers that a patent for the use of bichromate and gelatine in steel engraving was taken out in this country by Fox Talbot in 1852.

Of the carbon processes that of Swan is described by the author, and the editor adds a brief account of the most recent improvements in this branch of the art adopted by the Autotype company. The last chapter of this part relates to the problems yet awaiting solution, and is chiefly devoted to an account of the attempts which have been made to photograph in natural colours.

The third and last part of M. Tissandier's book treats of the applications of photography. In the first chapter we have a description of the various heliographic and photo-lithographic processes which have from time to time been invented, including those of Donné, Fizeau, Niepce de Saint-Victor, Poitevin, Baldus, Garnier and Salmon, Albert, and Obernetter. The second chapter, under the title of "Photoglypty," is devoted to a description of the Woodbury process, after which follow two chapters on photo-sculpture and photo-graphic enamels. Chapter V. treats of photo-micrography, and is illustrated by several excellent engravings of photographs of microscopic objects. The following chapter describes the application of photography to war. The method of sending microscopic despatches by carrier-pigeons adopted during the siege of Paris will be of interest to our readers. The despatch having been printed was reduced by photography on to a collodion film, which was then rolled up and enclosed in a quill, which was fastened to the tail of the pigeon. We here reproduce a facsimile of one of these microscopic despatches. To read the despatches sent in this way the collodion film was unrolled by immersion in weak ammonia water, dried, placed between two glass plates and a magnified image projected on to a screen by means of a photo-electric microscope (see Fig. 2).

Chapter VII. treats of astronomical photography, and touches upon the results achieved in this branch of the art by Warren De la Rue, Secchi, Rutherfurd, Grubb, &c. The author is not quite accurate when he states that for astronomical photography "it is indispensable to make use of a reflecting telescope having a speculum formed of glass silvered according to Foucault's process." The experiments of Rutherfurd show that lenses may be used with excellent results. Chapter VIII. describes photographic registering apparatus, barometric, thermometric, magnetic, electric, &c.; and Chapter IX. is devoted to stereoscopic photography.

Chapter X. treats of the applications of photography to art, while the last chapter discusses the future of photography. The author expresses a hope that among other developments which the art is destined to undergo, the time may come when it will be possible to photograph by telegraphic means.

The foregoing sketch of the book will be sufficient to enable our readers to form an estimate of its contents. The translation appears to have been carefully made, and the engravings, of which there are over seventy, are excellent. The frontispiece portrait, by B. J. Edwards and Co.'s photo-tint process, is a beautiful example of permanent photographic printing. In conclusion, we can heartily commend M. Tissandier's book as a popular *exposé* of photography.

R. MELDOLA

OUR BOOK SHELF

Morocco and the Moors: being an Account of Travels, with a General Description of the Country and its People. By Arthur Leared, M.D. Oxon, F.R.C.P., &c. (London: Sampson Low and Co., 1876.)

MANY readers, we believe, know less about Morocco than they do about Lake Tanganyika, the Fiji Islands, or the Arctic regions. Not that there are no easily accessible works on the country; no one, we conceive, who might be anxious to "get up" Morocco would have much difficulty in collecting trustworthy authorities, both in English and French. The modern general reader, however, has so much to do to keep up with a decent percentage of the literature of the day, that, unless for a special purpose, he is not likely to unshelve works of travel of a past generation; therefore, even for countries near at hand and whose names occur almost daily in Reuter's despatches, it is useful now and again to have the narrative of a recent visit. Morocco, though comparatively near us, yet in many respects is so isolated and so far behind the age, that a trustworthy account of its condition is welcome. Dr. Leared was only a few weeks in this country in the autumn of 1872. He landed at Tangier, visited the neighbourhood, sailed down the coast to Mogador, calling at one or two places on the way, and at a time of great internal disturbance visited the city of Morocco, where an attempt was made to poison him, happily without success. He managed to make a very good use of his time and his eyes and his introductions, and the reader will find many interesting observations on the people and the country. Dr. Leared has, however, not confined himself to his own observations, but has evidently diligently studied various authorities on the country, and taken trouble to acquire information from various quarters. The results he presents throughout the work as he goes along, and especially in a series of concluding chapters on the country and the people, government, law, education, superstitions, agriculture, natural history, &c. The appendix contains a variety of valuable material, including meteorological observations for Tangier and Mogador. Dr. Leared is strongly impressed with the value of Morocco as a resort for phthisical patients, the climate in some parts, he thinks, being in this respect superior to that of almost any other place. To anyone wishing to have a pretty full, and on the whole trustworthy account of the present condition of Morocco, we can honestly commend Dr. Leared's book, which, we should say, contains a small map and numerous illustrations.

Tyrol and the Tyrolese: the People and the Land in their Social, Sporting, and Mountaineering Aspects. By W. A. Baillie Grohman. With numerous illustrations. (London: Longmans, 1876.)

WHATEVER other qualities Mr. Grohman's book may possess, it is at least intensely interesting. The author is by birth half a Tyrolese, and he has spent several years in the country, evidently living frequently in all respects as a native, and thus having unusual opportunities of becoming thoroughly acquainted with the country and the people. What we have said in speaking of Dr. Leared's work on Morocco, might be applied with equal force to Tyrol, which, although the yearly resort of hundreds of tourists, is known to most only on the surface. Mr. Grohman's chapters give one a very satisfactory idea of the character and customs and general life of the people, and his sketches of the mountain scenery and of the habits of the chamois and black-cock are interesting, and in the latter case may furnish naturalists with a few additional facts. The people themselves are evidently made of splendid stuff, but at present rough and raw, and sorely in need of being polished. They are overridden with superstition, and in many of their customs, especially in the matter of social morality, have a strong resemblance to what the Scotch were generally a generation or two ago, and are still in some remote districts. The book is mostly occupied with Mr. Grohman's personal adventures, and one is sometimes inclined to suspect that these have been pieced together so as to tell effectively. This, however, simply adds to the interest, and does not detract from the value of the work. One of the most interesting chapters describes an ascent of the Gross Glockner in the dead of winter by the author and four guides. The illustrations are very beautiful, and the book, we should think, is likely to find many readers.

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 Late Eclipse

AN answer to Mr. Proctor (vol. xiii. p. 186) is unnecessary to those who know all that has been written on the possibility of photographing the spectrum of the corona, but I take the liberty to give a few quotations out of the literature on the subject for the benefit of those who take an interest in the discussion, yet had no opportunity of following it in detail. Want of space prevents me from quoting all the letters in full, but I believe that I have not left out anything which might alter the sense of the quotations. The passages which seem to me to be important to the point at issue are printed in italics.

1. Letter to the Editor of the *Daily News*, signed Richard A. Proctor, January 26, 1875 :—

"It is said that some enthusiastic students of science propose to try to get photographs, not of the corona as seen in a telescope, but of the exceedingly faint coronal image seen with a spectroscope. If they succeed they will have achieved a clever photographic feat, but the result, so far as the corona is concerned, can have little scientific value. *It is mathematically demonstrable that this is the case, for the quantity of light actually forming the coronal image can be shown to be far less in amount than is necessary for the formation of a satisfactory photograph.*"

2. Letter signed "A Fellow of the Royal Astronomical Society" (*English Mechanic*, May 21, p. 248) :—

. . . . "But if Mr. Proctor should take upon him to answer the first of these questions in the affirmative, the second in the negative, then I could ask him *whether any body or any set of men possessing the slightest knowledge of the subject could or would have issued the preposterous instructions about photographing the spectra of bright lines in the corona, which emanated from the Royal Society?* The bright lines in the corona! Why, it has been recorded again and again by skilful observers that so faint is the light of the whole corona during the totality of a solar eclipse, that it casts no shadow whatever; and we know that the outer parts of the corona failed utterly to impress a collodion plate in five seconds, upon which a sharp and effective image of the partially eclipsed moon impressed itself in 0·1 second with a longer focussed telescope!"

(I should not have quoted in your columns any remarks of this anonymous writer had not Mr. Proctor's reference to them in the following letter rendered it necessary.)

3. Letter from Mr. Richard A. Proctor (*English Mechanic*, May 28, 1875, p. 272) :—

"With respect to the eclipse observations last April, I have already said, as 'F.R.A.S.' does (let. 9,113, p. 248), that the failure of the Government expedition was rendered certain by the instructions of the Royal Society Committee. I pointed this out also before the expedition started. *I agree with 'F.R.A.S.' entirely in his interpretation of the matter.*"

Taking these letters in connection with what Mr. Proctor now writes, the following seems to be Mr. Proctor's opinion :—

It is mathematically demonstrable that "the quantity of light forming the coronal image is far less in amount than is necessary for the formation of a satisfactory photograph" (*Daily News*), yet "Dr. Schuster proves very readily that the spectrum of the corona can be photographed in one minute" (NATURE).

Mr. Proctor "is not aware that anyone has questioned the fact," but he "fully agrees with an anonymous writer that no set of men having the slightest knowledge of the subject could have issued the instructions which emanated from the Royal Society."

The failure of the Eclipse Expedition was rendered certain by the instructions of the Royal Society Committee to photograph in four minutes what Mr. Proctor admits to be capable of being photographed in one minute.

Anything which Mr. Proctor could have written on the subject besides what has been quoted, as, for instance, the passage in "Science Byeways," he alludes to in his letter, can only add to the hopeless confusion which must bewilder anyone trying to form a correct and fair estimate of his view on the matter.

Everybody will agree with Mr. Proctor that such a controversy is not likely to be of any service to science.

Upper Avenue Road, Jan. 1 ARTHUR SCHUSTER

The Fossil Skeletons of Le Puy en Velay

As there is to be a meeting of the Scientific Congress of France in Auvergne and Velay next summer, it may be useful to direct attention, through the columns of NATURE, to certain difficulties connected with the supposed antiquity of the fossil human bones preserved in the Museum of Le Puy.

With respect to the position of the bones, I visited the locality they were supposed to be found in last September, in company with some friends, and we were conducted, by the peasant who professes to have found them, to a well near the little auberge, where he now resides, and which is certainly a very different spot to that indicated by Mr. Poulett Scrope in his sketch at page 182 of the "Volcanos of Central France." The locality given by Mr. Scrope is much higher up the hill than is the well we were shown near the "Hermitage." Sir Charles Lyell also, according to the "Antiquity of Man," p. 229, was conducted to a spot "not far from the summit of the volcano." The well of the Hermitage is a long way from the summit of the hill.

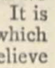
It has long been observed that the rocky matrix in which the human bones have been enveloped is altogether different from the matrix of the rock where they are said to be found. This is certainly the case as regards the matrix of the rock in which the well is situated, which is a coarse volcanic breccia, while the bones lie in a volcanic sandy mass with a mixture of tuff and lime. I especially wish to direct attention to the position of one of the larger bones marked (I think) as an "iliac bone" in the Museum. The laminated mass between which it rests appears to me *stalagmitic*, as if these human remains had been washed into a fissure through which the water percolates downwards to the well of the Hermitage, and of which traces may be found higher up the hill.

I would also direct attention to certain stratified breccias near the western summit of the hill of Denise, which we thought looked more like the result of melting snow and the action of running water than of "volcanic alluviums," to which they have been generally attributed. These may be seen beyond the Croix de Paille on the road to Briowde high up on the flanks of the hill west of the volcanic outburst known as "The Chimney." The black and red scoriæ shot out through this "chimney" cover the summit of the hill and overlie the stratified breccias. But these breccias are, if I read the geology of the district aright, the equivalents of those which, on the slopes of Denise, west of Polignac, have furnished the bones of the mammoth and tichorhine rhinoceros, and belong to glacial times.

The antiquity of the human skeletons must, I suggest, depend upon the correct determination of the spot where the bones were found. It is possible that they may belong to the age of the stratified breccias, and were washed into a crack or fissure during the Mammoth epoch, but they certainly do not look like it, if we may judge from the matrix in which they are enclosed. It is possible that they were enveloped in volcanic materials which were evolved during the last volcanic outbursts, for I believe that at Le Puy en Velay and in the Ardèches there have been eruptions of scoriæ and ashes through volcanic vents and chimneys since the glacial epoch, when deep snows covered the summit of Denise in the winter time and the mammoth pastured in the vales. W. S. SYMONDS

A Meteor in the Daytime

THE meteor referred to by the Rev. T. W. Webb was also seen at Dorking and at Southampton. The times given were "about 1.38 P.M." and "1h. 38m. 45s. P.M.," Dec. 22. Mr. H. J. Powell, writing to me from the former town, says: "Its course was from S.S.E. to N.N.W., and it shot down the sky so—



It had no well-defined outline like the moon, but was merely an irregular luminous ball. Its size as compared with the moon was about one-sixth. Its motion was not a very rapid one, but more like a cricket ball (after it has been thrown) falling. I did not hear any sound after its disappearance." Mr. Powell, writing to the *Times*, also mentioned that it "left a long trail of fire behind it," and that the nucleus "broke up and disappeared before it had reached the horizon."

In the *Times* of the same date (Dec. 23), "F. W." writes: "In the full blaze of the sun—a rare sight in itself nowadays—I observed a bright meteor traversing the sky from south-west to north-east, in form like a common rocket."

These accounts no doubt refer to the same meteor as that observed at Hardwick. WILLIAM F. DENNING

Tyndale House, Ashley Down, Bristol, Jan. 8

Blowpipe Analysis

MAJOR ROSS (NATURE, vol. xiii. p. 186) does not appear to have thought of the impurities his soda might contain in his test for the presence of a sulphide. Had he done so he would probably have remembered that all soda (unless specially prepared from sodium) contains traces of iron. This iron, on fusing with the sulphide, forms ferrous sulphide, which, as is well known, is soluble in fused sodium sulphide; and on adding water to the fused mass a black residue of ferrous sulphide remains behind.

Again, he says "there can be no room to precipitate anything in a drop of water;" but surely this is erroneous. It is only a question of degree. Under the same circumstances a precipitate would be as certainly formed in a drop of water as in a gallon.

If Major Ross were to make allowances for the ordinary impurities of commercial reagents, a little more confidence might be placed in his tests. T. S. HUMPIDGE

Marine Aquaria

WHILE reading Mr. Wills's very suggestive article on Marine Aquaria in your last issue, the following question suggested itself to me:—Does not the "larger proportion of carbonic acid in the lowest depths of the ocean" explain, at any rate partially, the formation of the "abyssal red clay," which Prof. Wyville Thomson has proved to occupy so large a portion of the bed of the Atlantic?

"Many of the insoluble carbonates, and in particular those of lime, magnesia, &c., may be dissolved to some extent by water, charged with carbonic acid, and are deposited in a crystalline form, as the gas slowly escapes from the fluid." (Miller's "Chemistry.")

That the presence of carbonic acid in the deep water is *one* cause of the decomposition of the shells of Mollusca, &c., I think that there can hardly be a doubt. Whether it is sufficient by itself to account for the whole phenomenon, I cannot presume to decide. H. J. M'G.

Bournemouth, Jan. 10

The Glow-worm in Scotland

MR. J. SHAW's interesting note on the Glow-worm leads me to remark that it is common about Loch Lomond, and recalls the pleasant surprise with which I met one there, shining brilliantly by the wayside, so late as twelve o'clock on a dark midsummer's night. WM. MCLAURIN

London, Jan. 10

Bryant and May's Safety Matches

THESE matches are highly electrical, and if they be rubbed against glass and ebonite they ignite, especially if the electrics be dry and warm. How far their ready ignition on amorphous phosphorus is due to chemism or to electricity remains to be proved. I am sorry I have not the opportunity just now to test this point. W. H. PREECE

OUR ASTRONOMICAL COLUMN

THE MINOR PLANET, No. 153.—This planet, discovered by Palisa at Pola on Nov. 2, 1875, and which has been named *Hilda* by Prof. Oppölzer, is found to have a period of revolution considerably longer than any other member of the group. In No. 39 of Prof. Tietjen's "Berlin Circular" is an orbit calculated by Dr. Schmidt, which represents closely the observations to the end of the year. It is as follows:—

Epoch 1875, Nov. 22, at Berlin midnight.

Mean anomaly	108° 30′ 11″	
Longitude of perihelion ...	284 41 50	1875·0
Longitude of ascending node	228 20 43	1875·0
Inclination to ecliptic ...	7 44 52	
Angle of excentricity ...	8 33 3	
Mean diurnal motion ...	452″·421	

The major semi-axis is 3·9474, and if we calculate the distance of the comet from the orbit of Jupiter at the aphelion passage, we find it 0·864, the earth's mean distance from the sun being taken for unity, which is a much closer approach to Jupiter's path than occurs with any other of the minors. Themis, for instance, the motion of which was investigated by Dr. Krueger, for determination of the mass of Jupiter, does not approach that planet within about 1·5. More than one of the small planets with the longer periods have large heliocentric latitude at the aphelion point, and do not on that account approach so near to the orbit of Jupiter as others with shorter periods and somewhat greater excentricities, and having the lines of nodes and apsides less divergent. Cybele in aphelion is 1·31 from the orbit of the great planet, Freia 1·24, and Camilla, according to the rather uncertain orbits yet available, 1·36. Hence, as suggested by Palisa, his planet Hilda is well situated for further investigation on the mass of Jupiter by the perturbations of the minor planets; it is well known, however, that this important element in the solar system is now reduced within narrow limits of uncertainty.

The above orbit of Hilda is confirmed by another computed by Herr Kühnert of Vienna from a similar extent of observations. The period of revolution is about 2,865 days, or approaching eight years, contrasting strikingly with the period of Flora, which is only 1,193 days, or a little over 3¼ years.

SATELLITES OF URANUS.—The following positions of the brighter satellites of Uranus are derived as before from Newcomb's Tables in the Appendix to the Washington Observations for 1873; they are for 11h. 30m. P.M. Greenwich time:—

	Titania.		Oberon.	
	Angle.	Dist.	Angle.	Dist.
	°	″	°	″
Jan. 15	23·2	31·1	66·5	23·8
„ 16	3·4	34·6	34·9	35·0
„ 17	347·7	43·1	18·5	44·0
„ 18	268·7	15·8	6·1	46·1
„ 19	212·5	27·2	352·6	40·5
„ 20	190·1	34·6	331·2	29·5
„ 21	169·1	28·9	286·7	21·1
„ 22	120·1	16·5	235·4	26·5
„ 23	45·4	22·4	209·7	37·9
„ 24	16·9	33·4	195·0	45·3
„ 25	357·5	32·1	182·7	45·3
„ 26	324·2	20·2	168·0	37·8
„ 27	245·2	18·0	142·2	26·5
„ 28	202·6	30·5	90·8	21·1

THE GREAT COMETS OF 1874 AND 1680.—Now that the orbit of the fine comet of 1874 (Coggia, April 17), determined from the observations in the northern hemisphere to the middle of July, has been shown by the southern observations extending to October, to require but small corrections, we may examine with confidence the path of the comet about the passage of the descending node, when it approached near to the orbit of Venus.

Employing the elements calculated by Dr. Geelmuyden, of the Observatory, Christiania, we have the following results:—

Heliocentric Ecliptic Longitude.	Heliocentric South Latitude.	Distance of Comet from Orbit of Venus.
299° 45′	2° 17′ 48″	0·003655
299 48	2 24 38	0·003181
299 51	2 31 29	0·003323
300 0	2 51 58	0·006372

Therefore, assuming the solar parallax 8″·875, with Clarke's semi-diameter of the earth's equator, the least distance of the comet from the orbit of Venus is found to have been 293,000 miles, or only about one-fourth greater than the distance of the moon from the earth.

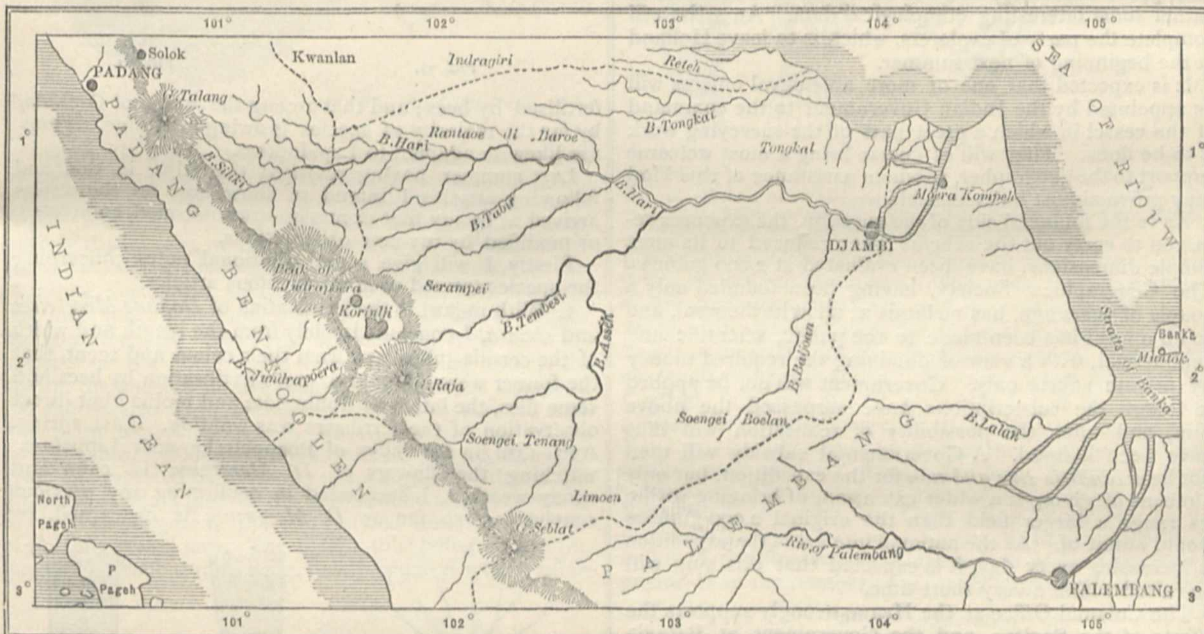
A very celebrated comet, that of 1680, approached the earth's orbit within even less than this distance. From the definitive elements of Encke it would appear that in 92° 3′·5 heliocentric longitude, just before traversing the plane of the ecliptic, towards the south, the comet's distance from our track was 0·0031, or 286,000 miles, but the earth at the time was in another part of her orbit and far away from the comet, which indeed never approached our globe within 0·42 of the earth's mean distance from the sun. To have brought the two bodies into their closest possible proximity in 1680, it would have been necessary that the comet should have arrived at perihelion at midnight on the 18th of January, 1681, in which case they would have met on the night of December 22.

No comet is yet certainly known to have been situate nearer to the earth than 1,390,000 miles, which was the distance of Lexell's comet of 1770, on July 1, at 5 P.M. G.M.T.

AN EXPLORING EXPEDITION TO THE INTERIOR OF SUMATRA

ONLY a short time ago the Geographical Society of Amsterdam took the first preliminary steps towards the realisation of a long-cherished idea,—the exploration of those parts of Sumatra which have hitherto been indicated by white patches on our maps of that island, even though they form part of the colonial territory. These regions are bounded to the south by the residencies of Palembang and Bencoolen, to the east by the Straits of Banka and the Sea of Riouw, and to the west by the highlands of Padang and the chain of volcanic mountains which traverses the island in its whole length, running parallel to the coast. All the above-named districts are tolerably well known, the native kingdoms of Reteh, Indragiri, and Kwantan, situated farther north, perhaps excepted. It is this white patch, better known under the name of the Djambi territory, which the expedition will choose for the special object of its researches.

For more than one reason this and no other part of the interesting island has been chosen. In the north the war with Atchin is for the present an impediment to a peaceful party of explorers, although a better acquaintance with those tribes of the Malayan race known as the Battaks would be highly interesting from a linguistic and ethnological point of view. This having to be given up, the question of the navigability of the Djambi River, which might, moreover, prove of so much importance on commercial grounds, induced the Geographical Society definitely to fix its choice on the indicated parts, rather than on Indragiri, Reteh, or any of the above-named districts.



The only European who has ever visited the domains of the Sultan of Djambi, and has left any official documents about the state of things as he found them, was the Palembang resident van Ophuyzen, who, in 1869, travelled a good way up the Djambi River, with the Government steamer *Boni*. Unfortunately, he was obliged to return sooner than he wished, for reasons dictated neither by the hostility of the population, nor by the barrenness of the country; on the contrary, he has reported very favourably on both these points. He had, moreover, occasion to notice the existence of several important tributary rivers, and as far as his survey extended he found the Djambi itself everywhere navigable. His reports to the Government at Batavia have formed a valuable basis upon which the Geographical Society has drawn up its projects for the present expedition.

The body of explorers will begin by separating into two parties, one of which will ascend the river in a steamer which it is expected Government will place at their disposal, the other party starting from Padang and passing the mountain chain above-mentioned somewhere between the volcanoes of Talang and Indrapoora, will try to follow the course of one or more of the Djambi tributaries—more especially the Batang Hari—from its source up to the point where they will meet the steamer with the rest of the explorers, who will have in the meantime ascended the river as far as possible.

This junction having been effected, the next task will be the detailed survey of the different courses of the Sangit, the Teboo, the Tabir, and the Tembesi, the party all the while slowly advancing towards those mysterious valleys in the interior of Korintji, Assei, &c., which have afforded so much matter for speculation, and about the beauty and fertility of which most wonderful accounts have long been circulated. For the only reliable data we possess, we are indebted to natives who have travelled to the coast for commercial purposes, information which cannot but be very imperfect. Unacquainted with the disposition of the inhabitants towards European intruders, our travellers will have to feel their way, using the utmost circumspection not to rouse the distrust of the population, which would undoubtedly be the case if Government was directly associated with the expedition. The natives would not fail to look upon this as a warlike demonstration, and their love of independence would then prevent the exploring party from accomplishing its task.

Not only from a geographical and ethnological point of view is this expedition expected to be a brilliant success, but also in the several departments of natural history the results are likely to be of high scientific value. A naturalist is to be appointed, who will accompany the explorers and enrich the zoological and geological departments of the national museum of Holland with interesting specimens from regions hitherto so superficially known.

There is some probability of a botanist being appointed by a committee of botanists and horticulturists, who will pay his expenses, and thus make the expedition profitable for this department of natural science as well.

The staff of the expedition will further consist of an able geographer, to whom the topographical department is to be confided, and of a linguist, who will study the languages of the tribes met with. It is a curious fact that in Sumatra the languages spoken by contiguous populations show very considerable differences. He will at the same time be able to serve as an interpreter, where this may prove necessary, and will no doubt have occasion to gather some interesting ethnological data. An artist will complete the party of explorers, which is to leave Holland in the beginning of next summer.

It is expected that one or more able naval officers will be appointed by the Indian Government to the command of the vessel in which a great part of the surveying work is to be done. They will of course bring a most welcome support to the geographer, to whom assistance of this kind may prove almost indispensable.

As to the financial side of the question, the expenses required to carry out the scheme when reduced to its most simple dimensions, have been evaluated at 2,000 guineas. The Geographical Society, having been founded only a couple of years ago, has no funds at all at its disposal, and so an appeal has been made to the public, scientific and commercial, with a view of obtaining the required money by private efforts only. Government will not be applied to before the subscriptions have surpassed the above sum, and when the possibility of realisation will thus have been assured. A Governmental subsidy will then not be a *conditio sine quâ non* for the expedition, but only a means of giving it a wider extension, of bringing within its range a larger field than the original 2,000 guineas would admit of. As the national interest in the expedition is increasing every day, it is expected that this sum will be raised within a very short time.

The Colonial Office at the Hague strongly supports the efforts of the Society, and the Government at Batavia has promised its earnest co-operation. Another favourable circumstance is to be found in the willingness of the Sultan of Djambi, now on the best terms with the Dutch colonial authorities, first, to permit of this scientific invasion into his domains, and secondly, to lend his assistance wherever this might be of any use. As a palpable proof he has already put his son-in-law at the disposal of the exploring party, for the purpose of accompanying them on their tours. Policy seems to play a part in the unexpected magnanimity of this potentate.

Let us hope the best for the realisation of all those promising plans, and may I, ere long, have the opportunity of bringing under your notice some results of an expedition by which science in general cannot but profit.

A. A. W. HUBRECHT

*FERTILISATION OF FLOWERS BY INSECTS**

XII.—*Further Observations on Alpine Flowers.*

LAST year, after having spent my vacation in the observation of Alpine flowers and their fertilisation by insects, I published some articles in this journal, in order to show that, in the Alpine region, Lepidoptera are far more frequent visitors of flowers than in the plain and in the lower mountainous region, while the frequency of Apidæ, not only absolutely but to a still greater extent relatively, greatly diminishes towards the snow line (see NATURE, vol. xi. pp. 32, 110, and 169). Further, in these articles I attempted to demonstrate that some Alpine species (*Daphne striata*, *Primula villosa*, *Rhinanthus alpinus*) are adapted to cross-fertilisation by butterflies, whilst the most nearly-allied species which inhabit the plain or lower mountain region (*Daphne Mezereum*, *Primula officinalis*, *Rhinanthus crista-galli*) are cross-fertilised by bees; and that among the family of Orchids, by far the majority of species growing in Alpine regions are likewise adapted to Lepidoptera.

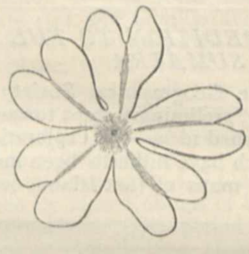


FIG. 71.

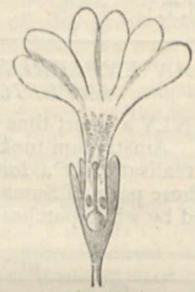


FIG. 72.

Last summer having revisited the Alps, in this and following articles I intend to show how far the results arrived at by my first excursion are confirmed, completed, or modified by my new observations.

Firstly, I will give some additional notes concerning the species treated of in my previous articles.

1. With regard to the fertilisation of *Daphne Mezereum* and *striata*, I concluded, solely from the length and width of the corolla-tubes, and from their colour and scent, that the former were adapted to cross-fertilisation by bees and some flies, the latter by Sphingidæ and moths; but direct observation of the fertilisers was wanting. Last spring, April 14th, in the valley of Poeppelsche, near Lippstadt, watching the flowers of *D. Mezereum* in calm and sunny weather, I succeeded in confirming my previous conclusions, so far as *D. Mezereum* is concerned, by direct observation. Some humble-bees which escaped to my net, several specimens of the hive-bee, and single specimens of *Anthophora pilipes*, F., ♂, *Osmia fusca*, Chr., ♂, and *Osmia rufa*, L., ♂, were perseveringly occupied in inserting their proboscides into the base of the corolla, apparently sucking its honey, whilst many smaller bees (*Halictus cylindricus*, F., ♀, *H. leucopus*, K., ♀, *H. nitidus*, Schenck, ♀, and *H. minutissimus*, K., ♀) were crawling with their whole bodies into the corollas, partly in order to suck the honey, partly collecting the pollen. Some Muscidæ also visited the flowers, touching stigma, anthers, and different other parts, with the flaps of their fleshy mouth, and sucking the honey. Besides these Apidæ and Diptera, only one butterfly

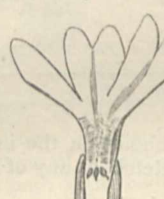


FIG. 73.

FIG. 74.

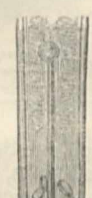


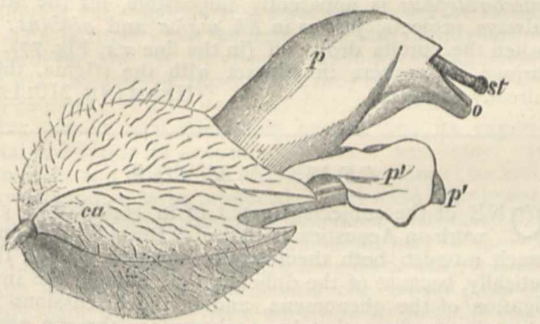
FIG. 75.

* Continued from vol. xii p. 191.

(*Vanessa Urticæ*) was attracted by the bright colour of the flowers, and inserted its proboscis into several of them, possibly without touching stigma and anthers.

Of *Daphne striata* I had not yet the opportunity of observing the fertilisers; but completely white flowers of this species, which I found in the pass of Strela, near Davos, may be considered as confirming my supposition that *D. striata* is adapted to crespuscular and nocturnal Lepidoptera.

2. Regarding *Primula officinalis* and *villosa*, no additional remarks are to be made. I have, however, observed another Alpine species of Primula (*P. integrifolia*), which



FIGS. 76-81. *Rhinanthus alectorolophus*.* FIG. 76.—Lateral view of the flower.

is apparently adapted, like *P. villosa*, by the narrowness of the entrance of its corolla-tube, to butterflies. And with regard to some other species which inhabit higher Alpine localities (*P. longiflora*, and *P. minima*) I suppose that they are in the same condition, *Primula integrifolia*, which I found frequently on the summits surrounding the passes of Strela and Fluela, is dimorphic, like most other species of this genus. Its sexual organs are quite included, the stigma of the long-styled and the anthers of the short-styled form occupying nearly the centre, the anthers of the long-styled and the stigma of the short-styled form occupying the lower part ($1\frac{1}{2}$ mm. above the ovary and 3 mm. above the ground) of the corolla-tubes. (Compare Figs. 72 and 73, 74 and 75.) Honey is secreted by the ovary in such quantity that it fills up the lowermost part of the corolla-tube so far as nearly to reach the stigma of the short-styled and the anthers of the long-styled form. The corolla-tube being 10-17 mm. long and about 2 mm. wide, its dimensions would allow

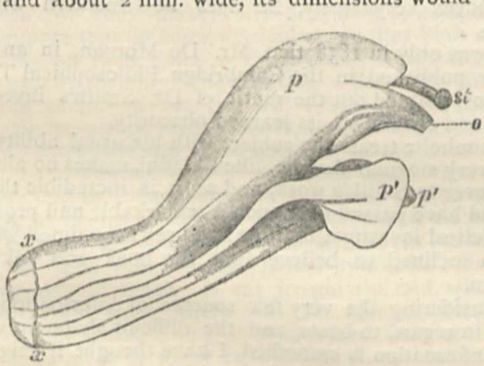


FIG. 77.—The corolla viewed laterally.

humble-bees also access to the honey; but the entrance to the corolla being contracted to 1 mm. (Fig. 71), no other insect but a lepidopterous one would be enabled to insert its proboscis into the base of the flower and reach the honey. On the other hand, the corolla is narrow enough to force also the thin proboscis of a butterfly to touch, when inserted, both the stigma and the anthers. I do not doubt, therefore, that *P. integrifolia* is also cross-fertilised by butterflies, although, from the unfavourable state of the weather, I have had no opportunity of observing its fertilisers.

3. *Rhinanthus alpinus* last year attracted my attention only during the last days of my stay in the Alps, when rainy weather prevented me from observing its fertilisers;

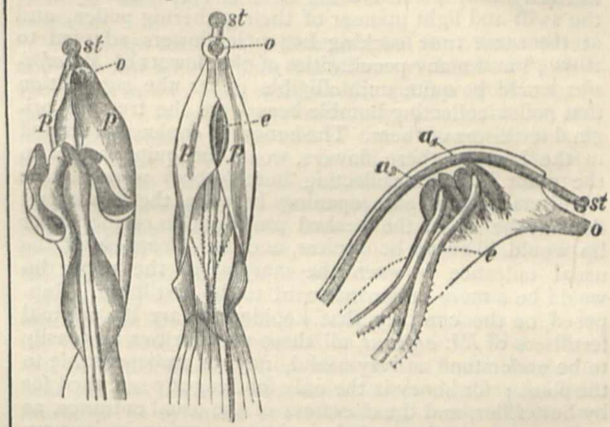


FIG. 78. FIG. 79. FIG. 80.

FIG. 78.—Front view of the upper part of the corolla. FIG. 79.—The same with the under lip removed. FIG. 80.—The upper part of the corolla, longitudinally dissected, but all four anthers reversed.

I concluded, solely from the structure of its flowers, that it was adapted to butterflies. This year it was an object of my continued attention; and in a region where Lepidoptera are predominant, but humble-bees are also very frequent, near Tschuggen (1,900 to 2,000 m. above the sea-level), Forno (1,800 m.), Valcava (1,500 m.), and St. Gertrud, Sulden (1,800 to 1,900 m.), I had large opportunities of directly observing its fertilisation by insects. But I was greatly struck by the fact that in these localities humble-bees visit its flowers far more frequently than butterflies. The number of visits which *Bombus alticola*, Kriechb. ☿. *mastrucatus*, Gerst., ☿ ♀, *terrestris*, L. ☿, *prâtorum*, L. ☿, and *Proteus*, Gerst., ☿, in these localities make to the flowers of *Rh. alpinus*, is at least ten times greater than the number of visits by butterflies (*Argynnis*

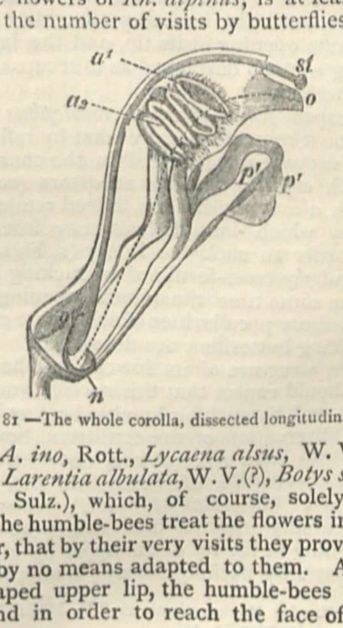


FIG. 81.—The whole corolla, dissected longitudinally.

Aglaia. L., *A. ino*, Rott., *Lycaena alsus*, W. V., *L. semiargus*, Rott., *Larentia albulata*, W. V. (?), *Botys spec.*, *Psodos quadrifaria*, Sulz.), which, of course, solely search for honey. But the humble-bees treat the flowers in such a forcible manner, that by their very visits they prove that these flowers are by no means adapted to them. Alighting on the helm-shaped upper lip, the humble-bees are obliged to turn round in order to reach the face of the flower

* All the figures are $3\frac{1}{2}$ times natural size. In all figures: *ca*, calyx; *p p*, upper petals, forming together the upper lip; *p' p' p'*, lower petals, forming the lower lip; a^1, longer stamens; a^2, shorter stamens; *n*, nectary; *ov*, ovary; *st*, stigma; *e*, usual entrance for the humble-bees; *o*, minute opening for the butterflies. The dotted line in Fig. 80 indicates the path of the proboscis of sucking humble-bees; the dotted line in Fig. 81 the path of the proboscis of butterflies.

then, the entrance between the margins of the upper lip being completely closed, they forcibly break it open with their fore-legs, grasping with them between the margins, and shaking the anthers in order to gain their pollen; thus a good deal of the smooth, powdery pollen grains, falling out of the shaken anthers, is received within the brushes and feathery hairs of their fore-legs, and thence carried to the pollen-collecting orifice of the posterior tibiæ. This incommodious and wearisome labour, although performed by the humble-bees with admirable dexterity and perseverance, contrasts remarkably with the swift and light manner of their gathering pollen, and at the same time sucking honey in flowers adapted to them;* and many peculiarities of the flowers of *Rh. alpinus* would be quite unintelligible under the supposition that pollen-collecting humble-bees were the true and original fertilisers of them. The honey, so copiously secreted in the base of these flowers, would be quite useless to the plant if pollen-collecting humble-bees were its true fertilisers; the minute opening between the two lateral flaps at the tip of the beaked prolongation of the upper lip would likewise be useless, and the closeness of the usual entrance between the margins of the upper lip would be a mere embarrassment to the fertilisers. Supposed, on the contrary, that Lepidoptera are the original fertilisers of *Rh. alpinus*, all these peculiarities are easily to be understood as very useful, nay, as indispensable to the plant; for honey is the only food eagerly searched for by butterflies, and the closeness of the usual entrance, as well as the existence of the minute opening in its very place, are required in order to induce visiting butterflies to insert their proboscis in the only manner which can effect cross-fertilisation. Hence, in spite of the frequent visits of pollen-collecting humble-bees, and in spite of their probably effecting many cross-fertilisations, the flowers of *Rh. alpinus* are without any doubt to be considered as adapted exclusively to butterflies.

But considering the original function of the under lip as a landing-place for bees, and considering that the most nearly-allied genera, *Euphrasia*, *Melampyrum*, *Pedicularis*, as well as *Rhinanthus crista-galli*, are all adapted to bees, we can hardly doubt that also the ancestors of *Rh. alpinus* have been adapted to cross-fertilisation by bees, and the question may be started, by what connecting forms these ancestors could be transformed into the present form of *Rh. alpinus*. We may confidently suppose that they retained the usual entrance for humble-bees, until the beaked prolongation of the upper lip, the minute opening at its tip, and the lateral flaps of this opening were so developed as to secure cross-fertilisation by butterflies.

In this respect *Rhinanthus alectorolophus* is of especial interest; for it represents really what by reflection we are induced to suppose once existed in the connecting forms between *Rh. alpinus* and its ancestors (compare Figs. 76-81). *Rh. alectorolophus* has indeed retained the usual entrance by which humble-bees may insert their proboscis in order to suck the honey (*e*, Figs. 79, 80), and may be regularly cross-fertilised by sucking humble-bees, whilst at the same time the minute opening (*o*, Figs. 76-81) and all those peculiarities which secure cross-fertilisation by sucking butterflies, are developed.

From the structure of its flowers, as shown by Figs. 78-81, we should expect that this species would be cross-fertilised as well by sucking humble-bees as by butterflies. My direct observation of the fertilisers, however, in the same localities with *Rh. alpinus*, shows no remarkable difference between *Rh. alectorolophus* and *Rh. alpinus*. Two species of butterflies—*Colias Phicomone* and *Pieris Napi*—repeatedly inserted their thin proboscis into the minute opening at the tip of the upper lip of *Rh. alectorolophus*, apparently sucking honey; numerous specimens of *Bombus mastrucatus*, Gerst., ☿♀, *terrestris*, L. ☿, *Proteus*, Gerst., ☿, and *pratorum*, L. ☿, were occupied in collecting the pollen of *Rh. alectorolophus* in quite the same manner as in *Rh. alpinus*. Only twice I saw humble-bees (*B. mastrucatus*, Gerst., ☿) sucking the honey of *Rh. alectorolophus*, but not legitimately, by the entrance between the margins of the upper lip, but rapaciously; once by inserting their proboscis on the underside between calyx and corolla, and piercing the corolla-tube a little above its centre; another time by forcibly passing its proboscis through calyx and corolla.

Finally, it is to be noted that self-fertilisation of *Rh. alectorolophus* is apparently impossible, for the stigma always projects, just as in *Rh. major* and *alpinus;* and when the corolla drops off (in the line *x x*, Fig. 77), and brings its anthers in contact with the stigma, this is already withered.

HERMANN MÜLLER

* Compare Æsculus Hippocastanum in "H. Müller, Die Befruchtung der Blumen durch Insecten," p. 155.

*BEATS IN MUSIC**

ONE of the subjects treated of in Helmholtz's great work on Acoustics is that of "Beats." It is one of much interest, both theoretically and practically: theoretically, because of the difficulty that attends the investigation of the phenomena, and of the discussions and misunderstandings that have taken place thereon among writers on scientific harmonics; practically, because beats might form an element of great utility in regard to certain practical operations, were it not that their nature and use are at present almost entirely unknown to practical musicians.

The history of the knowledge of beats is curious. They were mentioned as early as 1636 by Mersenne, and were afterwards noticed by Sauveur and others, but no sufficient explanation of their theory was given till the publication in 1749 of the learned work on Harmonics by the celebrated mathematician Dr. Robert Smith, Master of Trinity College, Cambridge. Dr. Young and Dr. Robison, both eminent writers on acoustics, quarrelled about Smith's work. Young said it added nothing to the knowledge of the subject, whereas Robison declared that it contained the greatest discoveries made since the days of Galileo; the fact, however, being probably that neither of them appreciated the main portions of the work at all. Chladni appears never to have studied the more difficult portion of the subject, and though he gives generally his references very freely, he does not mention Smith's name.

It was only in 1858 that Mr. De Morgan, in an able paper, published in the Cambridge Philosophical Transactions, pointed out the merit of Dr. Smith's investigation, and cleared up its learned obscurity.

Helmholtz treats the subject with his usual ability, but it is very singular that he, like Chladni, makes no allusion whatever to Smith's work, and as it is incredible that he should have passed over such a remarkable and profound theoretical investigation if he had been acquainted with it, I am inclined to believe that the book was unknown to him.

Considering the very few sources of information that exist in regard to beats, and the difficult shape in which this information is embodied, I have thought it might be useful, especially to practical musicians, to attempt to give some account of the subject in a more popular form; and in doing so I will endeavour to introduce the investigations of Smith, in combination with those of the later investigator.

There are three distinct kinds of beats, differing considerably from each other in the nature of their causes and in the circumstances that attend them, and the confusion between them has caused much error in their

* By W. Pole, F.R.S., Mus. Doc. Oxon.

investigation. Hence a correct discrimination between them is very desirable.

The first and simplest kind of beat we will distinguish by the name of the *Union Beat*, it being produced by the concurrence of two sounds nearly, but not quite, in unison with each other. Let two organ-pipes, or any other sustained sounds, be tuned first exactly in unison; the combined effect will be equable and smooth, undistinguishable from a single sound. But now let one of the notes be put out of tune, at first very slightly; the result will be a peculiar effect of wavy pulsation or *beating*. The exact description varies according to the fancy of different hearers, but it is usually said to resemble an alternation of different vowel sounds, like *waw*, *waw*, *waw*, or *ya*, *ya*, *ya*. The beating, when the notes are but slightly out of tune, will be slow; if the error is made worse, the pulsations will increase in rapidity, till they become too quick to be counted.

This fact is very commonly known, and its experimental exhibition is exceedingly simple and easy. If organ-pipes and the means of tuning them cannot be had, the two sounds may be produced on any wind instrument, which can be easily put into the adjustment necessary. Or one of two unison reeds of a harmonium may be thrown out of tune by weighting it with a little bit of wax; indeed, in the drawing-room instruments one unison stop is usually made purposely out of tune with another, the composition giving a tremulous effect resembling the shaking of the voice, the stop being named "voix celeste" (in Italian organs a stop called the "vox humana" is formed of two pipes tuned in a similar way). These are real unison beats with so short a period as to produce the tremulous effect in question. Two unison tuning-forks may also be thrown out of tune by attaching wax to the arm of one of them, which will make it a little flatter.

The beats may also be well produced on a violin. Stop A with the fourth finger on the third string, and play it along with the second string open, when the adjustment of the former may be made with the greatest nicety, and if it be put out of tune the resulting beat will sometimes be so prominent as almost to shake the instrument under the chin. On a pianoforte the beats may also be observed when one wire of a note is a little sharp or flat of another, although this case is not so favourable for observation, from the sounds not being sustained.

Now, in seeking for the explanation of this phenomenon, a homely preliminary illustration will be useful. Suppose two coffin-makers live next door to each other, and suppose that on some particular day they both strike the blows on their nails at exactly the same rate, and begin exactly together; the effect on a passer-by will be that the sounds of the two will reach his ear simultaneously, smoothly, and regularly, and he will have difficulty in distinguishing the combined sound from what would be produced by one workman only. But now suppose that by some change in the fancy of one of the men, A, he begins to strike a little faster than his neighbour, making, we will say, eleven strokes to ten of the other, B. The effect on the passer-by will be changed, the sounds will reach his ear irregularly, and, which is the important thing, there will be regular periodical phases appreciable; for it is obvious that at every tenth blow of B, or every eleventh of A, the blows will *coincide*, after which they will diverge and become irregular till they coalesce again.

To apply this illustration to the case of the sounds, it must be borne in mind that a sound is transmitted to the ear by waves of the air, each of which consists of an alternate condensation and rarefaction. The coincidences of sound-waves give rise to peculiar effects of *interference* of various kinds, but it will suffice here to say that when two condensations coincide, the effect will be different to that when the condensation of one wave coincides with the rarefaction of another. It will be easily seen that when the vibrations producing two sounds are a little unequal in time, as if, for example, one vibrates eleven times while the other is vibrating ten; there will be periodical coincidences corresponding to those of the blows just mentioned, and it is these periodical coincidences that produce the effect of what is called the *beat* on the ear.

Having thus established the nature of the beat, we may now go a little further, and see what we can find out about its time, or the length of the period which it involves, and this is a matter which requires careful attention.

We will go back to the illustration of the coffin-makers, and will now assume that the slower workman, B, makes 100 blows in a minute, whereas the quicker workman, A, makes 101. It will be evident that a coincidence will take place exactly at the end of every minute of time, so that, for these numbers, the periods of coincidence (corresponding to our beats) will be *one* per minute. Let now A increase his speed to 102 blows per minute, the other remaining the same; here there will be one coincidence every fiftieth blow of B, or every fifty-first of A, *i.e.* there will be two coincidences per minute.

It is easy to apply this to the sound-vibrations. Let one note make 100 double vibrations per second, and let the other note be sharpened to make 101. Here there will be one coincidence, or, what is the same thing, one beat per second. · If the second note is sharpened a little more, so as to make 102 vibrations, there will be two coincidences, or two beats per second.

Hence the rule has been derived, that *the number of beats per second is equal to the difference of the number of vibrations per second of the two sounds.*

This is a simple rule, and it happens to be *practically* an accurate one; but hasty writers, who have deduced it from one or two simple examples, have omitted to see a curious *theoretical* difficulty that attends it. Let us go a step further, and suppose the higher note to make 103 vibrations per second, while the other makes 100: how many beats per second would this give? The rule says three, but if we examine very carefully the succession of sounds, we shall find there will *not* be three coincidences per second, there would be only *one*, and hence the rule will appear to fail. But if we try the experiment we shall hear that there *will* be three beats, and hence the theory and the fact do not correspond.

To explain the discrepancy, let us revert again to the illustration of the coffin-makers: supposing A to make 103, and B 100 strokes per minute, the interval between A's stroke is = $\frac{1}{103}$ of a minute, and between B's = $\frac{1}{100}$. The 33rd stroke of B will take place after $\frac{33}{100}$ of a minute, and the 34th of A after $\frac{34}{103}$, and as these fractions are not the same, it is clear that the blows will not coincide, neither will the 66th and 68th; in fact, there will be only one point in each minute when the blows will be heard exactly together.

Yet if the passer-by be asked to count with his watch how many coincidences per minute he hears, he will assuredly say *three*, and this discrepancy between theory and fact demands to be reconciled.

The explanation was cleverly hit upon by Dr. Young, who ("Experiments and Inquiries respecting Sound and Light," sec. xi.), treating of the subject, mentions "coincidences, *or near approaches to coincidences.*" He saw that, so far as the ear was practically concerned, a near approach would answer the purpose of an exact coincidence equally well; and this clears up all the difficulty. For although the 32rd and 34th blows do not come together with *theoretical exactness*, they come *practically* so nearly together that the difference between $\frac{33}{100}$ and $\frac{34}{103}$ is only $\frac{1}{10300}$, that is, the difference in time between the two blows is only $\frac{1}{10300}$ of a minute, which no passer-by could appreciate, and he may therefore say they coincide.

Similarly, with the sounds. Although the 103 vibration-sound and the 100 vibration-sound only coincide with theoretical accuracy once in a second, yet there is, three times per second, a coincidence so nearly accurate (within $\frac{1}{10300}$ of a second) that the practical effect in producing the beat is the same.

The rule, therefore, is practically right; but it should be qualified scientifically with the following addition:—*When the two vibration-numbers are prime to each other* (*i.e.* when they are not both divisible by any whole number) *the rule is not theoretically accurate, but if the times of vibration are very small* (*as they always are in practice*) *the error has no practical effect, and the rule consequently holds good.*

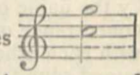
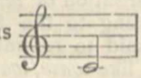
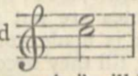
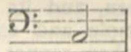
With the aid of this rule we can now tell the exact number of unison beats that will correspond to any amount by which the two notes are out of tune; and, *vice versâ*, we can tell the exact quantity by which two notes intended for unisons are out of tune by simply counting the number of beats they give. For example, suppose the A open string on the violin is played along with the fourth finger note (first position) on the third string, and that the latter is a little sharp, so as to give four beats per second, we know that the upper note will have four vibrations per second more than the other; and as at this point of the scale about twenty vibrations go to a semitone, we can tell that the upper note is about one-fifth of a semitone sharper than the lower one. To effect this, the fourth finger must be moved about one-twelfth of an inch nearer the nut than the former position, and this can be measured if any player think it worth the trouble, as a check to the calculation.

We may next inquire what effect on the ear is produced by changes in the rapidity of the beats. At first, when they are slow, no very unpleasant sensation is perceived, but as they become faster they give a sensation of roughness which is disagreeable in a marked degree. With a further increase of rapidity the effect becomes again less unpleasant, until it arrives at the slight tremulousness already mentioned in the *voix celeste* and *vox humana* stops, and which, as it is purposely produced, may be supposed to be rather agreeable than otherwise.

If we carry the error farther, the beats become so fast that the ear ceases to be able to appreciate them, and the beating effect entirely disappears.

Helmholtz, who has paid much attention to this subject, and who has founded on this property of beats some important musical speculations, is of opinion that the disagreeable effect increases gradually until the beats arrive at about thirty per second, where the harshness is at a maximum; that then the unpleasantness lessens as they grow faster, until, at about 100, or something more, per second, the beating effect disappears. Hence he calls from O to this point *beating distance* for any two notes near each other.

For example, if starting from the treble C, 512 vibrations per second, we sharpen the note to D♭, 546 vibrations, and then sound this with the original C, we shall get $546 - 512 = 34$ beats per second, which gives a very harsh effect. If we go on to D, 576 vibrations, we shall get, for the interval C to D, $576 - 512 = 64$ beats per second, which is less harsh; and if we go on to C with E♭, we shall have $614 - 512 = 102$ beats, which is hardly perceptible. For C to E, a major third, we have $640 - 512 = 128$ beats, and no one can assert that this interval, when in tune, has anything harsh or disagreeable about it.

A curious question has existed as to what becomes of the beats when they thus vanish. Are they entirely annihilated? or do they in their more rapid shape produce any other sensible effect of any kind? To explain the answer that was, by early writers, given to this question, one must mention a new phenomenon which occurs in connection with double sounds, namely, what is called the "grave harmonic." When two notes are sounded together they give rise to a third tone, of a fainter strength, and generally lower than both. Examples of this are usually taken from concords: thus, if the following two notes  are sounded on an organ, a violin, or any instrument of sustained sounds, and are perfectly in tune, the ear will, with attentive listening, hear a faint third sound resulting therefrom, which will be an octave below the lowest note of the concord, thus . If, instead of the fifth, the major third  be sounded, in like manner the "grave harmonic" will be an octave lower than before, namely, . This phenomenon was discovered by Tartini, the eminent violinist, and is often on this account called the "Tartini harmonic."

Now it happens that the number of vibrations of Tartini's harmonic, for any two given notes, is exactly the same as the number of the unison beats for the same notes, as hereinbefore described: and hence the idea arose that when the beats became so rapid as to lose their beating character, they gave rise to the grave harmonic; the explanation naturally presenting itself, that a beat recurring regularly with the proper rapidity would produce on the ear the effect of a musical sound. Dr. Young was the first to publish this explanation: he says ("Experiments and Inquiries respecting Sound and Light," sec. xi.), "The greater the difference in the pitch of the two sounds, the more rapid the beats, till at last they communicate the idea of a continued sound, and this is the fundamental harmonic described by Tartini."

Young's theory has been generally accepted until within the few last years, and in consequence the kind of beat we have been describing has been called "Tartini's beat." Helmholtz has lately thrown doubt on the correctness of Young's explanation, but the analogy of the numbers may warrant us in retaining the name, as distinguishing this beat from others which we will now proceed to describe.

(*To be continued.*)

UNITED STATES NATIONAL ACADEMY OF SCIENCES.

THE half-yearly meeting of the National Academy of Sciences was held at Philadelphia, Nov. 2, 3, and 4, 1875.

Prof. Joseph Henry has for several years been conducting the researches of the U.S. Lighthouse Board in respect to Fog Signals and the Transmission of Sound. While these experiments are not yet completed, the results up to the present time give the following indications:—The echo of sound passing over the ocean is more probably due to reflection from the surface of the waves than from the air; sound coming against the wind can certainly be heard at an elevation from a greater distance than at the sea level; with the velocity of the wind at about five miles an hour, sound was heard five times further with the wind than against it; sound is heard furthest with a moderate wind; with a strong wind it is not heard so far as in still air.

Prof. Joseph Le Conte, of California, contributed the results of his observations on mountain ranges of the Pacific coast. The author's theory is that the mountain chains in question were formed wholly by a yielding of the crust of the earth, along given lines, to horizontal pressure; not, however, resulting in a convex arch filled and sustained by liquid beneath, but by a mashing together of the whole crust, producing close folds and a swelling upwards of the squeezed mass. Prof. Le Conte went on foot through a cut made by the Central Pacific railroad from near St Francisco Bay eastward, a distance of 30 miles through the Coast range, which consists of two sub-ranges wholly of crumbled strata. The average angles of dip are from 65° to 70°. The following estimates are made:—The folded strata are of $2\frac{1}{2}$ to 3 times the length of a horizontal line drawn beneath them; *i.e.* 15 to 18 miles of sea bottom have been crushed into 6 miles, the surplus swelling upward. Numerous flattened clay pellets, chiefly ellipsoids or disks, and similarly flattened nodules of sandstone, furnished means of estimating the horizontal and vertical pressures to which the mass has been subjected. The mathematical formula employed was detailed. It was found that $2\frac{1}{2}$ to 3 parts had been crushed into one horizontally, and every foot of vertical thickness had been thereby swelled up $2\frac{1}{2}$ or 3 feet.

Major J. W. Powell of Washington has spent many years in scientific exploration of the cañons of Colorado latterly under the auspices of the Smithsonian Institution. He regards the geology of the Colorado region as so different from any other, that a new system will have to be devised to meet it. Major Powell offered the outlines of a new system for the details of this region, proposing to retain as far as possible the names that mark the labours of previous explorers in the field; and to give in addition geographical names as a provision expedient till the full order of the strata should be determined. The plateau region drained by the Colorado River of the West was more particularly under review in the essay before the Academy. Springing from the plateaus are single mountains, short ranges, and volcanic cones disposed in groups; the affluents of the river have their source in high mountains on the edge of the drainage basin. The river and its chief tributaries differ from other great rivers in the absence of considerable valleys along their course, at least north of 35° latitude. The streams run in deep cañons, and these, with other topographic features, separate the plateaus. This is part of the whole region of the United States west of the 100th meridian, which is distinguished by being everywhere of great altitude, with the trifling exceptions of a strip on the Pacific coast and some valleys of the larger streams. The rivers descend so rapidly that they are of little service for navigation; the valleys are exceedingly narrow; the table-lands and mountains are treeless, arid, and almost desolate. Bare rocks rarely masked by any soil give character to the "Rocky Mountain" region. Here there is everywhere an open book to the geologist, as the formations can be clearly traced, and the sections given by cañons display in regular succession the strata of palæozoic, mesozoic, and cainozoic eras, a total depth of 60,000 feet being thus revealed. The characteristics of the formations of this region were discussed at considerable length. As an instance of the irregularities of strata, the observations on lignite may be cited. It is frequently found through a horizon of 11,500 feet, in beds of varying thickness, distributed all the way from the lower Cretaceous up through three divisions of the Tertiary; but no particular bed of lignite is persistent over a large area. In one instance—the Rock Springs group—eleven beds of lignite were found, varying from 10 inches to 4 feet in thickness; but three miles away, careful observation showed all these beds represented by carbonaceous shales. In places separated by only a distance of a few miles, the succession of lignites is found to differ materially; they appear in general to have been formed in small irregular basins.

One of the most interesting papers read at the meeting was that of Prof. Raphael Pumpelly, of Newburgh, N.Y., on the Influence of Marine Life and Currents on the formation of Metalliferous Deposits. Beginning with the list of chemical elements which are found in the sea—now numbering 29 and likely to be largely increased—the author gave disinctive particulars as to the proportions of these substances, and the material in which they are found, whether sea-water, marine organisms, or structures that are products of marine life. All elements which compose the land are ultimately carried to the sea. The cycles through which different substances pass in their progress from land to sea, and thence again to the material of land, were traced in the cases of carbonic acid, lime, phosphoric acid, fluorine, and sulphur. As to the first of these, the sea is charged with nine per cent. of CO_2, the charge varying with the surface condition of the water and the immediate atmospheric conditions. The activity of the wave surface aids the escape of surplus carbonic acid into the air. Plant life in the sea as on land effects the decomposition of CO_2, using the carbon to build vegetable structure and freeing the oxygen to sustain marine vegetable life. But the carbon that is withdrawn to form coal, owing to its insoluble character, has been practically abstracted from this circulation. The ultimate result, the author thinks, would have been the decay of all life on the planet, for the want of the carbon thus locked up. Hence the work of man in mining and burning coal restores the balance of this circulation, by bringing the carbon into a condition in which it can be dissolved by moisture and enter into plant life through the leaves.

In describing the cycle of lime, Mohr's theory was alluded to. Sulphate of lime, decomposed by plants, supplies sulphur towards forming albumen by combining with carbon and ammonia, the oxygen being set free; carbonate of lime may perform a simpler operation in the plant, leaving behind the carbon and lime while liberating oxygen. The hydro-carbons are afterwards oxidized in the respiration of animals that feed upon the plants, and secrete structures of limestone.

Phosphoric acid and fluorine have slight chemical affinity, yet they are continually found associated in mineral deposits. Phosphate of lime and fluoride of calcium offer nearly equal resistance to solution by atmospheric and aqueous agencies. The first is a constant constituent of marine plants; both are found in the lower marine animals, and by their means are presumably brought together again in rock formation. Land plants and animals take a frequent part in this circulation. Disintegrated rocks form soil-supporting vegetation afterwards eaten by animals, whose digestive processes bring the substances in question into the more soluble states, in which they are most readily carried to the ocean.

The sea contains much dead organic matter, and in decomposition the sulphur of the sulphates and of the albumen plays an important part. As to the sulphates, the direct process of their decomposition in decaying organisms may be stated thus:—The carbon of the organic substance takes the oxygen from sulphuric acid and its base, giving a sulphide of the base and free carbonic acid; water and carbonic acid decompose the sulphide again, giving sulphuretted hydrogen and a carbonate. Oxidation of the sulphuretted hydrogen gives sulphuric acid, which in time, uniting with lime, completes the circuit of sulphur. On land the processes are far more intricate. It is probable that in the circuit of sulphur in marine organisms is to be found the key to their powers of eliminating from sea-water the heavier metals. The habitat of marine plants is determined by ocean currents, the growth and development being dependent upon freedom from such disturbance. Animal life follows vegetable. The accumulation of organic existence at certain localities in the ocean—as for instance the sargossa—determines there, in the process of its decay, the position of the material of rock formations, including the heavy metals which have been thus eliminated from their dispersion in sea-water. A thorough and minute chemical analysis of the earth brought up by the soundings of the *Challenger* and the *Tuscarora*, would be apt to throw light on some of the details of these problems.

The "Difference Engine," a calculating machine devised by Mr. George B. Grant, and now in course of construction for the University of Pennsylvania, was described by Prof. Fairman Rogers. The frame of the machine is 8 feet by 4 feet. To this frame are attached, though removable at will, 100 similar parts or elements, each of which is a small adding machine, representing a single decimal place during operation. When these elements are combined in groups, each group represents a certain difference of numbers, such as by consecutive additions to a starting number gives the required mathematical table or series. The difference thus added may be constant or variable. A table of squares is made by adding two differences, one constant, the other variable; cubes add three differences of which only one is constant. Logarithms are obtained similarly, though the operation is more complex. In this machine certain groups of elements are set to constant differences, and transfer their products in figures to other groups, which in turn transfer their variable values to groups above them. Babbage's machine was more costly, and Scheutz's more complicated than this; its chief advantages are: interchangeableness and ease of grouping of the elements, a constant introduced by simple apparatus in each element; an improved method by which the figure produced by any element is sent to the corresponding element in a higher group, and greatly improved arrangements for the operation of "carrying." The main figure-wheel of each element is moved forward by a carrier, which is released at the proper point by an inclined edge that takes it out of the way of the wheel. When a carriage is to be made, as for instance, if the wheel be at 8 and 3 be added, making 11, the next wheel standing at 0, which must be turned to 1, is so contrived that at the proper moment its inclined edge is slipped one tooth forward, and the carrier moves that wheel one step further than it otherwise would. This principle is so extended to successive carriages that if a long row of nines is up, and unity be added on the wheel on the right, all the nines are at once replaced by zeros and one is added to the figure on their left. The machine presents a *cliché* of figures, the basis for a stereotype plate; it will calculate and print a table to ten decimal places at the rate of about forty turns per minute. A two-horse power engine will be required to drive it to its full capacity.

An arithmometer, or multiplying machine, devised by Mr. Grant, was also shown with, for comparison, those of Thomas de Colmar and Baldwin, it being adapted to the same purposes as those, but constructed on the principle of the difference engine.

Prof. R. E. Rogers gave some facts of interest respecting the silver mines known as the Comstock Lode. In the deeper drifts the temperature is much higher than can be explained by the usual hypothesis of interior heat; it frequently reaches 150° F. Water trickling from the roofs of these drifts is so hot as to be almost scalding; workmen have to be protected from it by iron screens. An application of ice-water to the head at intervals is found necessary to the support of life. The heat is due to chemical action, principally to the decomposition of sulphide of silver deposits which takes place when water containing chloride of sodium reaches them. There is some saline material in the ore. It is a singular fact that while there appears to be no trace of copper in the ore, the washing from the quicksilver mills, which runs into a pond and there evaporates, leaves a deposit which is only 300 fine instead of 700, all the rest being copper. To extract the silver, this deposit is put into a cap-like receptacle of felt, and hot quicksilver is turned upon it, which strains through, and carries with it the copper and gold, leaving the silver. The next process is to separate the gold from the copper in the drippings. To effect this the combined substance is heated to fusion and allowed to cool, when the two metals segregate, and the gold cracks off the copper. Before the discovery of this process the "tailings" of the mills had no value; now they prove of considerable worth.

Prof. J. Lawrence Smith has been studying a crystalline product obtained from the graphite of meteoric iron, that proves soluble in ether and crystallises in acicular form. Wöhler and Roscoe have announced the discovery of a similar substance in carbonaceous meteorites. Prof. Smith finds it in carbon nodules in the very centre of large masses of meteoric iron. Wöhler and Roscoe regard it as a hydro-carbon; Prof. Smith gives reasons for considering it a sulpho-hydro-carbon.

In another communication Prof. J. Lawrence Smith described a pendulum designed to meet the wants of a cheap and efficient compensating arrangement for common clocks. Prof. Smith has taken advantage of the great expansibility of vulcanite under changes of temperature. His experiments, in common with those of others, prove that its coefficient of expansion is about that of mercury, between 0° and 212°. In applying this simple form of compensating pendulum to clocks, he states that it need not add more than twenty or thirty cents to the cost of the pendulum ordinarily in use. He has constructed one with more perfect means of adjustment, yet very simple in character, which he thinks can be attached to regulators and astronomical clocks. Prof. Smith is now engaged in investigating any possible change in the materials used that may interfere with the permanency of this instrument; from the nature of the subject it will take some time to arrive at the necessary results. In these experiments he is assisted by a very competent associate.

The following were the papers presented at the session, in addition to those already mentioned:—Contributions to Meteorology, by Prof. Elias Loomis; Exposition of several peculiar Astronomical Phenomena, by Prof. Stephen Alexander; Confirmation of same author's Theory of the Zodiacal Light, by the same; Composition of Schorlomite, by Prof. George A. Koenig; Modern System of Chemical Terminology, by Prof. R. E. Rogers; Steam Geysers of California, by the same; the Annular Nebula in Lyra, by Prof. Edward S. Holden. Prof. C. E. Dutton's paper on certain Igneous Rocks of Southern Utah was read by title only.

NOTES

PROF. HILDEBRAND HILDEBRANDSSON has published in the "Transactions" of the Royal Society of Sciences at Upsal, a clear and interesting account of a tornado which occurred near Hallsberg, in the province of Nerike, Sweden, on the 18th August, 1875. From the full details he gives it is evident that it closely resembled the tornadoes which have been described by the American meteorologists and the well-known tornado of Chatenay of 18th June, 1839, described by Peltier. Upwards of 1,000 large trees (*Pinus abies*), covering a space 1,000 feet in length by 500 feet in breadth, were totally destroyed, the greater number being torn up by the roots, whilst those about the margins of the path of the tornado were snapped across. On emerging from the forest, where its course had been directed to N.N.E., it turned in the direction of N.E., uprooting trees, overturning solid buildings, and carrying the *débris* of the ruins, in some cases, many miles from the scene of destruction. From the positions of objects thrown down, which are shown on a map, Dr. Hildebrandsson points out that in this instance the destructive force was compounded of two forces, one being directed towards the centre of the tornado and the other in the line of its course. The true theory of these terrible phenomena can only be arrived at by such carefully observed and collated facts as Dr. Hildebrandsson here presents us with; and much light would be thrown on this difficult question if barometric and thermometric observations were made within and near the district swept by the tornado.

YESTERDAY'S *Standard* contains a letter from the *Challenger* correspondent of the paper, dated Valparaiso, Nov. 19. Honolulu was left on August 11 and a call made at Hilo (Hawaii), when the crater of Kilauea was visited. On the 19th the *Challenger* left and made for Tahiti, soundings and dredgings being carried on by the way, the average depth being 2,800 fathoms, with a bottom of red clay. Oxide of manganese was brought up in large quantities, and "many things of great interest to the naturalist." Several excursions were made on the Island of Tahiti, and every opportunity was made use of to get acquainted with the productions, soil, climate, and inhabitants. Sail was again made on Oct. 2, and Juan Fernandez reached on Nov. 13, the average depth of the section being 2,160 fathoms. Hill and dale were tramped over by the naturalists and others during the two days' stay, and numerous specimens of birds and plants obtained. Valparaiso was reached on the 19th.

PART II. of the first volume of the new series of the "Transactions" of the Linnean Society, just published, contains a paper by Dr. J. D. Macdonald, on the external anatomy of *Tanais vittatris*, occurring with *Limnoria* and *Chelura terebrans* in excavated pier-wood, and another by Dr. M'Intosh, on *Valencinia armandi*, a new Nemertean. The first part contains Mr. Parker's memoir on the skull of the woodpeckers, one by the late Dr. R. v. Willemoes-Suhm on some Atlantic Crustacea from the *Challenger* Expedition, and one by Dr. Allman on the structure and systematic position of *Stephanoscyphus mirabilis*, the type of a new order of Hydrozoa.

SOME living specimens of the gigantic Tortoises of the Galapagos Islands, which were on their way to this country in H.M.S. *Repulse*, were lost, we regret to say, in a gale which did some damage to the ship and caused the death of two of the crew.

A NEW journal, *The Scientific Monthly*, devoted to the natural and kindred sciences, has been quite recently started at Toledo, Ohio, Mr. E. H. Fitch being the editor.

MESSRS. H. HOLT AND CO., New York, will publish during the month a work entitled "Life Histories of Animals, including Man," by Mr. A. S. Packard, jun. This work having appeared in parts in the *American Naturalist*, we can most certainly vouch for its excellence.

WE regret to have to announce the death of Mr. S. T. Davenport, well-known as an active and energetic officer of the Society of Arts. Mr. Davenport's connection with the Society had lasted for thirty-three years, and it was in great part to his unceasing and zealous efforts that the present prosperity of the institution is due. All who take an active interest in the Society of Arts will feel his loss severely.

An unfortunate difficulty at present prevents the Algerian Meteorological Service from sending telegrams daily to M. Leverrier for tabulation. It appears that the hour chosen at which to take the readings is seven in the morning instead of eight, the hour that has been adopted by all European nations. M. Leverrier could not by any means make use of the Algerian data in his daily weather maps. It is to be hoped that Algerian meteorologists will see the necessity of conforming to the rule universally adopted in European observatories. But some resistance is expected from those who have adopted the unusual hour for taking observations, as they contend that the readings taken then give a closer approximation to the mean state of weather. This assumption is hardly justifiable by facts: at any rate it cannot be considered as an objection to the taking of a reading at eight o'clock, and sending it by telegram to Europe.

At Christ Church, Oxford, there will be an election on Saturday, March 11, to at least two junior studentships in Physical Science, of the annual value of either 100*l*. or 85*l*., tenable for five years.

The *Geographical Magazine* announces the discovery of a voluminous journal kept by Father Desideri, who resided and travelled in Thibet in the early part of last century.

The Dutch Government have adopted a plan for draining the Zuyder Zee at an expense of nearly 10,000,000*l*. The area to be drained is estimated at 759 square miles.

The Bureau of Agriculture of the United States Centennial Commission (not the United States Agricultural Department) has lately issued a circular, which announces that it is proposed to have an exhibition of living fish of many varieties, for which purpose plans have been prepared for the erection of twenty-five tanks of approved construction, ranging from two to twenty feet in length and from one to six feet in depth, the whole containing about six thousand cubic feet of water. The cost of these aquaria is estimated at $6,000. The Bureau of Agriculture desire to render this enterprise in a measure self-supporting, and the circular invites those interested in the subject to purchase one or more ten-dollar shares of the Centennial stock, with the understanding that the proceeds, although going into the general fund, are to be considered as contributed to the fish exhibition.

Mr. G. S. Boulger, F.G.S., has been appointed Professor of Natural History in the Agricultural College, Cirencester.

The North-German *Allgemeine Zeitung* of Jan. 7 publishes a long article on the Hamburg Naval Observatory. It appears that this establishment commences operations to-day, and professes to include the several branches of scientific seamanship. The establishment is said to have been fitted up according to the most improved method, regardless of cost.

Two Parisian daily papers, the *Bien Public* and the *Opinion Nationale*, publish daily the weather maps designed by M. Leverrier for the international meteorological service.

The list of the members of the French Bureau des Longitudes has been published. Besides the ordinary members appointed either by the Bureau or by the Academy of Sciences, the War Office, and the Marine Department, a number of correspondents have been appointed, including M. Stephan at Marseilles, M. Tisserand at Toulouse, M. Marie Davy at Montsouris (Paris), Admiral La Ronciere le Nourry, &c.

The meteorological *Annuaire* of the Montsouris Physical Observatory has been published by M. Marie Davy. Excellent woodcuts show the details of the several anemometers and magnetometers used by the institution. The results of all the readings taken in the preceding year have been carefully tabulated. The maximum registered velocity of the wind was 80 kilometres an hour, and the maximum pressure 47 kilogrammes per square metre.

M. Leverrier may come to London in order to be present at the distribution of medals by the Royal Astronomical Society. The printing of his tables for Saturn is progressing favourably. The verifications made have been satisfactory.

A very useful and complete summary of the geographical progress of 1875 will be found in *The Colonies* for January 8. The same well-conducted paper has commenced a series of "Ethnographical sketches of the various aborignal or indigenous races inhabiting countries and islands that are becoming daily more known to us through the rapid development of trade and commerce," but whose inhabitants are disappearing or being greatly changed. The first sketch, under the head of Pacific Islands, is of the Hawaiians or Sandwich Islanders.

The Italian Minister of Public Instruction has made a grant of 1,000*l*. for the scientific expedition to Central Africa (see Nature, vol. xiii. p. 155).

A pithy article in the Hastings and St. Leonard's *News* of the 7th inst. calls attention to the scientific destitution of that favourite watering-place. There seems at one time to have been an apology for a museum, but its dusty contents have long ago been scattered. So far as we know, Hastings has not even a local scientific society or field-club, although the district around, including the sea and its shore, would furnish a fertile field for such an association. Indeed, with the exception of a science and art class, Hastings seems to be quite destitute of any means of fostering a love of science or of scientific pursuits and recreations among its people. Surely there are a few men in the town who know the value of science; at all events, we hope the forcible remarks in the *News* will have the effect of rousing the people to bring their town abreast of its neighbours in the matter both of a well-furnished museum and a scientific society and field-club.

We take the following from the *Geographical Magazine*:—Announcement was made at a recent meeting of the Society for the Encouragement of Commerce and Industry, in St. Petersburg, that a person who does not wish his name to be known has offered a sum of 25,000 rubles (3,125*l*.) towards a scientific expedition to explore a commercial route from Northern Russia to Behring's Straits. Prof. Nordenskiold has agreed to accept the leadership of the expedition, which will start next summer. Subscriptions to the amount of 26,000 rubles (3,250*l*.) have also been received towards the cost of another expedition composed of two vessels, which shall last three years, and shall explore the Gulf of Obi as well as the sea-route between Archangel and the great rivers of Siberia. The command of this one will be entrusted to Capt. Wiggins, of Sunderland, who has, however, stipulated for full liberty of action in unforeseen circumstances, and who has remained in St. Petersburg, waiting for the replies of the Mayors of Irkutzk, Krasnoyarsk, Tobolsk, Tiumen, Tomsk, and Ekaterinburg, who have been invited by telegraph to co-operate in forwarding the enterprise. A reply has since been received from a proprietor of gold mines at Krasnoyarsk contributing 500*l*. to the expenses of the undertaking.

"From Vineyard to Decanter" (Stanford), the second edition of which has come to hand, is "a book about sherry." We would recommend it to all of our readers who love "a good glass" of that favourite British beverage. It gives a clear account of the processes through which the wine goes in all its stages, and the conclusion of the whole matter seems to be that if you wish to drink good sherry you must make up your mind to pay a good price for it.

THE *Revue Scientifique* announces the death of the naturalist M. Pictet.

THE *Cologne Gazette* states that Herr Heuglin, the African traveller, has declined the offer of the Khedive to take the command of the troops sent to Abyssinia, in place of the late Munzinger Pasha, but is organising an Abyssinian exploration for scientific purposes.

DR. VON RICHTHOFEN, the well-known traveller and geographer, has been appointed Professor of Geography at the University of Bonn. He is still occupied at Berlin with the editing of his great work on China.

THE additions to the Zoological Society's Gardens during the past week include a Le Vaillant's Cynictis (*Cynictis penicillata*) from South Africa, presented by the Viscount Maudeville; a Hooper Swan (*Cygnus ferus*), European, presented by Mr. Montague Kingsford; a Weeper Capuchin (*Cebus capucinus*) from Brazil, presented by Mr. August Kettner; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. T. J. Dunn; two Darwin's Pucras (*Pucrasia Darwini*) from China, purchased.

SCIENTIFIC SERIALS

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Nov. 15, 1875.—Dr. Billwiller, of Zürich, contributes an article on a local occurrence of the northerly "Föhn." It was formerly believed that the Föhn came from the Sahara Desert, whence it derived its warmth and dryness, but Hann showed a few years ago that, according to known physical laws, descending air becomes warmer and drier, that winds of the Föhn kind are not confined to the Alps but occur in other mountainous regions, and that the southern slopes of the Alps have a north wind, which is the exact counterpart of that called the Föhn. A mass of observations made in Switzerland have since proved the correctness of his theory. Herr Billwiller, from the data he has as yet examined, finds that isolated Föhn winds prevail only when a broad current flows over the whole Alps in the same direction, ascending on one side and descending on the other. But there are cases in which no perceptible upward movement can be traced on one side, and yet on the other the Föhn descends into the valleys from above. A difference of density, often great, is the cause of this. The lower strata being obstructed the outflow of air necessary to restore equilibrium comes from above. The merely local Föhn blows strongly down a valley, but on reaching the colder air of the plain mixes with it and quickly comes to rest. Tables are given showing meteorological conditions in particular cases.—The next article, written by Dr. Wild, and quoted here from the Annual Report of the Imperial Observatory at St. Petersburg, is a review of the work of the Meteorological Congresses of 1873 and 1874. Perhaps the most important result of these congresses will be the general use of more trustworthy instruments by official and private observers. The following advantages have already been gained: an international system of ciphers for telegraphic despatches throughout nearly the whole of Europe; an international form of publication in the following countries: Norway, Sweden, Denmark, Russia, Austria, Switzerland, Italy, and part of Germany; and lastly, the establishment in many States of central institutions. We shall thus obtain better, more uniform, and more accessible data as a consequence of the late congresses.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Jan. 6.—On the refraction of sound by the atmosphere, by Prof. Osborne Reynolds, Owens College, Manchester. Communicated by Prof. Stokes, Sec. R.S.

This paper may be said to consist of two divisions. The first contains an account of some experiments and observations undertaken with a view to ascertain how far the refraction of sound caused by the upward variation of temperature may be the cause of the difference in the distances to which sounds of the same intensity may be heard at different times.

Some rockets, capable of rising 1,000 feet, and then exploding a cartridge containing 12 oz. of powder, having been procured, an effort was made to compare the distance at which the rockets could be heard with that at which a gun, firing ¼ lb. of powder and making a louder report than the rockets, could be heard under the same conditions of the atmosphere. In the first instance the rockets and the gun were fired from a spot in Suffolk, around which the country is tolerably flat, observers being stationed at different distances. Owing, however, to the effect of the wind and the time required for the observers to proceed to the distant stations, these experiments were not successful in establishing the comparative merits of the gun and the rockets. They were, however, important as showing that on hot calm days in July the reports of the rockets never failed to be distinctly audible at distances of four and five miles, although the sun at the time was shining with full force on the ground, and rendering the air near the surface so heterogeneous that distant objects seen through it appeared to wave about and twinkle.

The next attempt was made during a cruise on the east coast. After three weeks cold and windy weather, the 19th of August was a fine day, and some experiments were made in Lynn Deeps, which revealed a very extraordinary state of the atmosphere as regards the transmission of sound. A party rowed away from the yacht in one of her boats, it having been arranged beforehand that either a rocket or a large pistol was to be fired from the yacht when signalled for; also that when those on the yacht heard those in the boat call they should answer. The boat proceeded to a distance of five miles, until those on the yacht had completely lost sight of it; but all the time the calls from the boat were distinctly heard by those on the yacht, although after they had lost sight of the boat they ceased to answer the calls. On the boat also not only were the reports of the pistol and rockets distinctly heard, but every answer from the yacht was heard plainly. The last came after an interval of thirty-five seconds, which gave the distance 3½ miles. Nor was this all; but guns, and on one occasion the barking of a dog, on the shore eight miles distant, were distinctly heard, as were also the paddles of a steamer fifteen miles distant.

The day was perfectly calm, there was no wind, the sky was quite clear, and the sun shining with great power—conditions which have been described as most favourable to the stoppage of the sound by the heterogeneity of the atmosphere, and which may also be described as most favourable for great upward refraction. On this day, however, it was observed that all the time distant objects *loomed* considerably, *i.e.*, appeared lifted. This showed that the air was colder near the surface of the sea than it was above. It is to this circumstance that the extraordinary distances to which sounds were heard on this day is supposed to be due. The diminution in the temperature of the air being downwards, the sound, instead of being lifted as it usually is, was brought down, and thus intensified at the surface of the water, which, being perfectly smooth, was thus converted into a sort of whispering-gallery.

The report of the pistol and the sounds of the voice were attended with echoes, but not so the reports of the rockets; and it is suggested that these so-called echoes may be found only to attend sounds having a greater intensity in one direction than in another.

The second part of the paper refers to a phenomenon noticed by Arago in his report of the celebrated experiments on the velocity of sound made on the nights of the 21st and 22nd of June, 1822.

It was then found that, although the guns fired at Montlhery could be distinctly heard at Villejuif (eleven miles distant), those fired at Villejuif could not be heard at Montlhery without great attention, and at times (particularly on the second night) they were not heard at all; although on both nights the wind was blowing from Villejuif to Montlhery, the speed of the wind, which was very light, being about 1 foot per second. No explanation of this phenomenon was offered by the observers, although it was much commented on. And on the second night the gun at Villejuif, which on the previous night had been pointed upward, was brought down in the hope that this might improve its audibility (this step was, however, found to render matters worse than before).

From this lowering of the gun at Villejuif it seemed as though there was probably some difference in the conditions under which the guns at the two stations were placed, as if that at Villejuif was fired from a level, while that at Montlhery might be fired over a parapet. An inspection of the district confirmed this view; for Villejuif is on a low, flat hill, while Montlhery is on the top of a steep cone; and not only is it 80 feet above Villejuif, but it is surmounted by the mound of an old castle, which is supported by a vertical wall towards Villejuif and surrounded by a low rampart. Hence it is suggested that in all probability the advantage of the gun at Montlhery was due to its being fired over this parapet, while that at Villejuif was fired from the level ground.

The fact that the wind blowing from Villejuif did not reverse this advantage, suggested the possibility that at night, when the diminution of temperature is downward, a light wind may not produce the same effect upon sound as when the diminution of temperature is upward, as it generally is during the day.

To ascertain if this is the case, some observations were made on some calm nights in May and June of the present year, from which it was found :—

(1) That the sky was cloudy and there was no dew. The sound of an electric bell 1 foot above the grass could always be heard further with the wind than against it; but

(2) That when the sky was clear and there was a heavy dew, the sound could invariably be heard as far against a light wind as with it, and in some cases much further. On one occasion, when the temperature at 1 foot above the grass was 38° and at 8 feet 47°, and the speed of the wind was 1 foot per second at 5 feet above the grass, the bell was heard 440 yards against the wind and only 270 with it.

Since, therefore, on the nights of the experiments at Villejuif and Montlhery it is stated that the sky was clear, that there was dew, and the temperature recorded at the two stations shows the diminution to have been downwards, it is argued that the effect of the wind to render the sound less audible at Villejuif was completely balanced by the downward refraction of temperature.

Another phenomenon recorded by Arago is, that while the reports of the guns at Montlhery as heard at that station were attended with prolonged echoes, this was not the case with those at Villejuif. It is thought that this difference is sufficiently accounted for by the fact that while Montlhery is surrounded by high hills with precipitous or wooded sides, which must produce echoes, the country in front of Villejuif is very flat and has not a tree upon it for miles.

In concluding the paper reference is made to the Appendix to the last Report of the American Lighthouse Board, in which Dr. Henry, the Chairman, gives an account of his experiments, extending over thirty years, and the conclusions to which they have led him; both of which are in favour of the apparent stoppage of the sound being due to refraction.

Zoological Society, Jan. 4.—Prof. A. Newton, F.R.S., vice-president, in the chair.—An extract was read from a letter addressed to the Secretary by Mr. George Brown, dated Port Hunter, Duke of York Island, stating that he had shipped for the Society to the care of Dr. G. Bennett, of Sydney, two cassowaries and some other birds from New Britain and Duke of York Island.—A letter was read from Mr. R. Trimen, Curator of the South African Museum, Cape Town, containing some remarks on *Canis chama*.—Dr. Hector, F.R.S., exhibited and made remarks on three ancient feather-mats, made by the Maoris of New Zealand, which had been obtained by Dr. Buller, from a chief on the Upper Wanganui River.—Prof. W. H. Flower, F.R.S., gave a description of the skull of a fossil species of the genus *Xiphodon*, Cuvier, from a specimen belonging to the Museum of the Royal College of Surgeons, supposed to have been found near Woodbridge in Suffolk.—Prof. Huxley, F.R.S., read a paper on *Ceratodus*, in which he pointed out the special characters presented by this remarkable fish in the structure of its nasal apertures, brain, skull, and fore-limb. Prof. Huxley also called attention to the close connection shown by certain details of structure between *Ceratodus* and the Chimæroid fishes, especially as regards the skull.—A communication was read from Dr. Julius Von Haast, F.R.S., containing the description of a new Ziphioid whale from the coast of New Zealand.—Mr. Sclater read a paper on some additional species of birds from St. Lucia, West Indies, which had been sent to him by the Rev. J. E. Semper of that island. The collection contained one very remarkable form which appeared to be referable to a new genus of *Mniotiltidæ*, and was proposed to be called *Leucopeza semperi*.—A communication was read from Mr. W. H. Hudson containing some notes on the spoonbill of the Argentine Republic.—A paper was read by Messrs. Sclater and Salvin, on Peruvian birds collected by Mr. Whitely, being the ninth of a series of communications on this subject.—A communication was read from Dr. Otto Finsch, containing notes on some Fijian birds, including description of a new genus and species proposed to be called *Drymochæra badiceps*.—Mr. A. H. Garrod read a note on the *cæcum coli* of the Capybara, as observed in a specimen recently deceased in the Society's menagerie.

Royal Microscopical Society, Jan. 5.—Mr. Chas. Brooke, F.R.S., vice-president, in the chair.—Messrs. W. A. Bevington and B. D. Jackson were elected auditors of the Society's accounts, and a list of gentlemen nominated for election as officers and council for the ensuing year was read by the Secretary.—Attention was called to a number of specimens sent to the Society a short time since by Mr. Hanks, of San Francisco, and which had since been mounted for the cabinet by Mr. Loy; also to some slides of *Aulacodiscus kittoni*, presented by Mr. Thos. Curties from material collected on the late Congo Expedition, by Mr. Martin, H.M.S. *Spiteful*.—Mr. C. Stewart then gave an interesting account of the structure and development of sponges, freely illustrating his remarks by drawings upon the black-board, and concluded by stating his reasons for believing that the well-known perforations in oyster-shell were really made by the sponge.—Mr. Hickie exhibited to the meeting some photographs from Germany of *Navicula crassinervis* and *Frustulia saxonica*, and read some letters from Dr. Rabenhirst and Herr Seibart in support of his opinion that the two were widely distinct.

Entomological Society, Jan. 5.—Sir Sidney Smith Saunders, C.M.G., president, in the chair.—Messrs. F. J. Horniman and D. G. Rutherford were elected ordinary members, and Prof. W. Dickson, of Glasgow University, and Mr. F. Enoch were elected subscribers.—The Rev. R. P. Murray exhibited a collection of Lepidoptera taken by himself on the Higher Alps, amongst which were some interesting mountain varieties.—Mr. S. Stevens exhibited a specimen of a dragonfly, rare in this country (*Æschnia mixta*), which he had picked up, nearly dead, in his garden at Upper Norwood, in the middle of November.—Mr. Champion exhibited some rare British Coleoptera.—Mr. H. W. Bates communicated a paper entitled "Additions to the list of Geodephagous Coleoptera of Japan, with synonymic and other remarks."—Mr. W. H. Miskin, of Queensland, communicated a description of a new and remarkable species of moth belonging to the genus *Attacus*, of which a male and a female specimen had been taken in the neighbourhood of Cape York. He had named the species *A. Hercules*. The expanse of the wings measured nine inches, and the hind wings were furnished with tails. The specimens had been deposited in the Queensland Museum.—Mr. C. O. Waterhouse forwarded a paper on various new genera and species of Coleoptera belonging to the *Geodephaga*, *Necrophaga*, *Lamellicornia*, and *Rhyncophora*.—Part IV. of the "Transactions" for 1875 was on the table.

MANCHESTER

Literary and Philosophical Society, Dec. 14, 1875.—Mr. Edward Schunck, F.R.S., &c., president, in the chair.—On graphic methods of solving practical problems, by Prof. Osborne Reynolds. In the first part of this paper it is pointed out that, when dealing with practical problems by the aid of the graphic method, it is not necessary to break off the operations of drawing, and find numerical values for the quantities represented, in order to perform on them the operations of multiplication and division. For by the aid of a parallel ruler the operations of multiplication and division may be performed graphically with great facility. The only geometrical proposition involved being that of finding a fourth proportional to three distances. When two distances have to be multiplied or divided the one by the other, a third distance is chosen equal to unity, and a fourth proportional found which represents the product or ratio of the first according as unity is the first or third of the given quantities. The method was illustrated as applied to the determination of areas, centres of gravity, and moments of inertia. In the second part of the paper a graphic method is described by which the velocity and acceleration of a moving point can be determined when the times at which it occupies certain positions are known, *i.e.* the curves representing the velocity and acceleration of the point may be drawn from the curve representing the positions of the point. Also a converse method by which the position of a point at any time may be found from the curve representing either its velocity or displacement.—On explosions of fire-damp. E. W. Binney, F.R.S., said that the fearful loss of life in our coal-mines deserved the careful attention of all societies like ours. It ought to be one of the objects of science to endeavour to find out the cause of these explosions, and to devise some means to prevent their occurrence or lessen their frequency. No doubt Government inspection had been of service, and the examination of managers would tend to improve the efficiency of mining officers; but still, notwithstanding these improvements, the explosions of fire-damp are sadly too frequent. The lamentable events which have taken place within the last few weeks clearly show that they sometimes occur without any great change in the barometric pressure of the atmosphere, although undoubtedly sudden depressions in a barometer ought to caution miners against emission of gas from the seam of coal and coal-wastes, and put the men more on their guard at such times. It has been stated in this Society that certain conditions of the atmosphere quite irrespective of barometric pressure may have something to do with causing the "drag" in the currents of air circulating through a mine, as explosions have frequently occurred during an east wind and a muggy state of the atmosphere, and a vesicular condition of water in the air has been suggested as the probable cause of this lessening of the speed of the air passing through the galleries of mines. Now, careful observations with a good anemometer in the return air-course of a mine ought to determine whether or not such an effect is produced, and thus settle this point by direct experiment. Another source of accidents at this time of the year has to be taken into consideration. Before Christmas and in cold weather there is often a brisk demand for coal, and both managers and men are in a hurry to increase the output, and under such circumstances probably there may be sometimes not so much care and caution exercised as are necessary for them to use in the dangerous work in which they are engaged. In the management of a fiery mine, in my opinion—1. There ought not to be any unventilated wastes. 2. The mixed use of Davy lamps and naked lights should not be permitted where the former are commonly employed. 3. Blasting of coal by gunpowder should not be sanctioned where Davy lamps are in common use. 4. An anemometer under the care of a competent man should be in constant use, in order to see that a sufficient current of air is passing through the workings to insure perfect ventilation of the mine. 5. When there are marked indications of firedamp in a mine, shown by a cap on the flame of a lamp, the men engaged in hewing and drawing coal should be removed from the pit until by ventilation the place is cleared of gas and rendered safe for a working collier. The above precautions may probably cause an increased cost in the getting of coal, but they are necessary for the preservation of human life if such catastrophes as now frequently occur are to be prevented. It is now pretty generally admitted that all explosions of fire-damp are caused by there being too little pure air and too much of that gas in a mine.—Chemical notes, by M. M. Pattison Muir, F.R.S.E., Assistant Lecturer on Chemistry, Owens College.

PARIS

Academy of Sciences, Jan. 3.—Vice-Admiral Paris in the chair.—M. Peligot was elected vice-president for 1876; and MM. Chasles and Decaisne were elected to the Central Administrative Commission. The following papers were read:—On the interior constitution of magnets, by M. Jamin.—New thermic researches on the formation of organic compounds; Acetylene, by M. Berthelot. The heat liberated by combustion of acetylene with free oxygen = + 321 cal. for C_4H_2 = 26 grs.—Final reflections on the production of saccharoid matters in plants, by M. Duchartre.—Ephemerides of the planet (156) determined by M. Rayet, from observations at Marseilles, by M. Lœwy.—On the way in which caloric vibrations may dilate bodies, and on the coefficient of dilatation, by M. de Saint-Venant.—Sixteenth note on the electric conductivity of moderately conducting substances, by M. Du Moncel. Minerals, when truly conductors, have but two kinds of conductivities, an electrolytic conductivity and one which is proper to them and approximates more or less to metallic conductivity. The electrotonic conductivity proper to dielectrics exists only in rocks known to be isolating and in crystals. But there are effects which imply a characteristic polarity of a moderately conducting medium.—New crystallised hydrate of chlorhydric acid, by MM. Pierre and Puchot. Mixing two parts of snow with one part of hydrochloric acid (cooled previously to − 15° or − 16°), one may obtain a temperature of − 35° C.—On a new fundamental law of electrodynamics, by M. Clausius.—On the study of thermic motors, and on some points of the theory of heat in general, by M. Hirn. This is an outline of Vol. II. of the author's work on Thermodynamics.—Osseous heads of fossil and actual human races; history of ethnic craniology; Negrito race, by MM. Quatrefages and Hamy.—Report on M. de Magnac's method for representing the daily course of chronometers.—Determination, by the principle of analytical correspondence, of the order of a geometric place defined by algebraic conditions, by M. Saltel.—On a point of infinitesimal geometry, by M. Serret.—On left cubics, by M. Appell.—Physiological conditions influencing the character of unipolar excitation of nerves, during and after the passage of a battery current, by M. Chauveau. He studies four cases: nervous system intact, spinal cord separated from brain, cord destroyed, and nerve cut above point of application of electrode.—On a commensal Amphipodan (*Urothoe marinus*) of the *Echinocardium cordatum*, by M. Giard.—Elliptic elements of the planet (157) Dejanire, and calculated ephemerides, by M. Stephan.—Researches on the law of transmission, by the earth's atmosphere, of calorific radiations from the sun, by M. Crova.—On the phenomena of induction, by M. Mouton. He studies the electric state of an induced bobbin with the ends unconnected, and too far apart for a spark to pass; a series of oscillations in potential is observed.—On the *rôle* of acids in dyeing with alizarine and its congeners, by M. Rosenstiehl.—On the phosphates of sesquioxide of iron and alumina, by M. Millot.—On a secondary hexylic alcohol, by M. Œchsner de Coninck.—On the assimilability of fossil phosphates, and on the danger of exclusive use of azotised manures, by M. Roussille.—On the preparation of gaseous bromhydric acid, by M. Bertrand.—Researches on the functions of glands in the digestive apparatus of insects, by M. Jousset. He was able, in *Blatta orientalis*, to obtain the liquids in the gland itself before entrance into the alimentary canal.—On the floral glands of *Parnassia palustris*, new physiological functions, by M. Hæckel. These glands are a carnivorous organ.—Undulations of the clay in the north of France, by M. Hebert.

VIENNA.

Geological Society, Dec. 7, 1875.—After welcoming Dr. E. Tietze on his return from Persia, M. von Hauer presented some papers sent in by Dr. K. Peters on the interesting limestone from the Sauerbrunngraben, near Stainz, in Styria, which encloses crystals of a plagioclastic felspar belonging to the species Albite.—Dr. A. Feistmantel, on the minerals of the peculiarly large-grained granite (Pegmatite) from the districts of Behar and Rangun, in Bengal. Among them large plates of mica are very remarkable, which the inhabitants make use of as ground for paintings, but they are also, like the Russian mica, brought to Europe for sale.—Dr. Kapf, of Stuttgart, on some very interesting remains of Saurians found in the so-called Stuben sandstone of Wurtemberg.—Dr. Mojsisovics presented the second volume of his work on the Mountains of Hallstadt, and gave a short account of its contents. In this volume the genera Arcestes (with 112 species), Didymites (with 6 species), and Lobites (with 26 species) are described, and illustrated in thirty-eight lithographic plates.—Dr. Dölter reported on the composition of the Melaphyres from the Southern Tyrol. Among the essential constituents of them, he recognised in some cases Amphibole, in others Augite.—R. Hörnes exhibited some remains of *Anthracotherium magnum*, from the coal-mines of Trifail, in Styria, and expressed the opinion that the carboniferous strata of Trifail and Sotzka are not identical with those of Eibiswald and Wies, but belong to an older stage of the tertiary period.

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