Nature. Vol. IX, No. 232 April 9, 1874

London: Macmillan Journals, April 9, 1874

https://digital.library.wisc.edu/1711.dl/LBXITYVRTMAPI83

THURSDAY, APRIL 9, 1874

BRITISH QUADRUPEDS

A History of British Quadrupeds. By Thomas Bell, F.R.S. Second Edition. (Van Voorst).

THIS excellent work having originally appeared in 1839, a second edition in 1874 deserves more than a passing notice. In a country like our own, which has been well populated for so many centuries, and in which the people are increasing at a rate only possible in connection with vast strides in our knowledge of sanitary laws, it is not difficult to form several deductions with regard to the nature of the changes which must be taking place in its fauna, together with their ultimate tendencies. As time progresses, works on the zoology of our island, now not many in number, nor large in size, must dwindle to the proportions of those that might be written on a country like China, in which by degrees nearly every wild species has been exterminated. As there, form after form must die out, giving place to the increase in numbers of the one dominant species, man; till in time a history of British quadrupeds will be better studied from the works of Hume and Lingard than from those of White and Bell. These and other considerations make it a question of more than ordinary importance what stress is to be laid, in scientific investigation, either for the purpose of classification or of minute study on the present geographical distribution of animals. On all sides we see remarks which show most clearly that their authors do not fully realise the true bearing of distribution. They think that it is in opposition to the Darwinian hypothesis; that the camel being found in Africa and Asia, whilst its only close ally, the llama, is a native of the Andes, is a significant fact in favour of the doctrine of "special creation," and the tapirs of Sumatra and South America, only, point in the same direction. But when we begin to realise how the whole fauna of countries can be and have been wholly changed within the extremely brief geologic time of man's existence, and that most palæontological evidence is in the same direction, it is clear that the stress which must be laid on the present distribution of any particular form is not so great as might have been imagined from the results obtained by earlier workers on the subject.

The strong predilection of our countrymen for sport also makes it highly improbable that any important fresh species of terrestrial mammals should be added to our fauna, and so we find that Mr. Bell's second edition includes only a single land animal which is not to be found in the first, namely, *Sorex pigmæus*, the Lesser Shrew, the smallest British mammal, with a total length, tail included, of less than 2½ in. The case is different, however, with respect to the aquatic species which visit our shores. The rapid strides made in our knowledge of the Cetacea by the excellent researches of Prof. Reinhardt. Flower, Turner, and others have considerably increased the number of existing genera and species; and this, taken in connection with the improvement in our powers of identification from the skeleton alone, has added so many as ten well-authenticated species new to our fauna The claims of the Greenland and Atlantic Right whales are however very feeble, and only a single specimen of Cuvier's whale, that described by Prof. Turner from Shetland, is known. Amongst the Phocidæ, also, a specimen obtained by Mr. J. H. Gurney, and identified by Prof. Flower, adds the Ringed Seal; whilst the Hooded Seal has been twice obtained from our eastern coast. Several changes have also had to be made among the Cheiroptera. None have had to be added, but some have been removed, on account of previous imperfect identification. The magnified views of the nose and head of each of our native species at the end of the different chapters, when taken in connection with the carefully compiled tables of measurements, will make it easy for anyone who obtains specimens of these rarely seen animals to identify them without much labour.

Mr. Bell in this edition of his work has, for several reasons, had to avail himself of the assistance of other workers in the same subject, for its completion. The Cheiroptera and Insectivora have been carefully revised and brought up to our present state of knowledge by Mr. R. F Tomes; but the latter part of the book, including all the new matter on the seals and whales, has been undertaken and most efficiently executed by Mr. E. R. Alston. This latter gentleman, from his acute discriminative powers and persevering industry, has made the portions of the work which it has been his good fortune to superintend the standard literature of the subject on which he treats.

Throughout the book there is an ease and elegance of style which is rarely found, now-a-days, in connection with the frequently but too dryly stated facts of science. This adds an attractiveness to the subject which implants and developes an extra charm in the mind of the reader, leading him on, by its inherent value, to the perusal of page after page, till he has finished the book, and unconsciously acquired an amount of zoological information, that, but for the manner in which it is presented to him, he would never have taken the trouble to acquire. As an example we may quote the description given of the wide-spread superstitions and prejudices which exist with reference to bats in general.

We read, "That the ancient Greek and Roman poets, furnished with exaggerated accounts of the animals infesting the remote regions with which their commerce or their conquests had made them acquainted, should have caught eagerly at those marvellous stories and descriptions, and rendered them subservient to their fabulous but highly imaginative mythology, is not wonderful; and it is more than probable that some of the Indian species of bats, with their predatory habits, their multitudinous numbers, their obscure and mysterious retreats, and the strange combination of the character of beast and bird which they were believed to possess, gave to Virgil the idea, which he has so poetically worked out, of the Harpies which fell upon the hastily-spread tables of his hero and his companions, and polluted whilst they devoured the feast from which they had driven the affrighted guests"—rather active measures for a Pteropine bat, no doubt, but none the less within the limits of human exaggerative powers.

We notice that Mr. Alston, in naming the families of the animals of which he writes, uses the termination -idæ on all occasions, as in Phocidæ, Balaenopteridæ, &c.; but in the earlier part of the work, when the generic name from which that of the family is derived, ends in -a, the termination -adæ is employed, so that we find the words, Ursidæ, Musteladæ, Talpadæ, &c. With all due deference to Mr. Bell, and in spite of the first line of Lucretius' poem, which commences with "Æneadum genetrix," we cannot help feeling that for the sake of uniformity and the feelings of the many propounders of scientific names who are not so well versed in the dead languages as they might be, it is better to continue the now nearly universally employed -idæ on all occasions.

The illustrations of the species described maintain the general character of the work, some being evidently new, as in the case of the deer. Many chapters have a picturesque and respectively appropriate sketch as a conclusion; and we notice that in the additional chapters, instead of fresh sketches, there are in their place (we say it with regret) views, both in profile and from above, of parts of the skeletons of the subjects of the text.

SCLATER AND SALVIN'S "NOMENCLATOR AVIUM NEOTROPICALIUM"

Nomenclator Avium Neotropicalium, sive avium quæ in Regione Neotropica hucusque repertæ sunt nomina systematicè disposita adjecta sua cuique speciei patria. Accedunt generum et specierum novarum diagnoses. Auctoribus Philippo Lutley Sclater et Osberto Salvin, (Londini: sumptibus auctorum, 1873). 1 vol. fol., 164 pp.

THE naturalists whose names are attached to the present work have been for some years working together on American ornithology. Besides numerous papers and articles of greater or less importance published in the "Ibis," the "Proceedings of the Zoological Society," and elsewhere, they completed in 1869 a quarto volume of "Exotic Ornithology," containing one hundred coloured lithographic plates representing new or rare birds of South and Central America, with accompanying letterpress. These works are understood to be all written with a view to the ultimate incorporation of the results arrived at in an "Index Avium Americanarum," or complete treatise on the ornithology of Central and South America. In further progress towards this end the authors now give us a "Nomenclator" or list of the generic and specific names of the species of birds as yet ascertained by them to occur in these countries, which form the "neotropical region" of Mr. Sclater—one of the six principal regions into which he has proposed to divide the earth's surface zoologically. After the name of each species is added the "patria" or "habitat," indicating the exact locality in which the species has been observed.

The neotropical region is now well known to be the richest in the world, ornithologically speaking; the "Nomenclator" contains the names of no less than 3,565 species of birds which, as the authors have convinced themselves by personal examination, are found in it. About 2,000 of these belong to the great order Passeres, and rather more than 1,500 to the nineteen other orders of birds met with in the neotropical region. One order alone is unrepresented in South and Central America, namely, the Apteryges, which is confined to New Zealand; but on the other hand the neotropical region possesses two peculiar forms of bird-life of ordinal rank (the *Opisthocomus* and the *Tinami*) which are unknown elsewhere. Besides these, many extensive families are entirely restricted to the limits of this region; for instance, the Tanagers with 302 species, the Humming-birds with 387 species, the Dendrocolaptidæ with 217 species, and the Formicariidæ with 211 species. A few Tanagers and Humming-birds have invaded the neighbouring nearctic region (*i.e.* America north of Mexico), but the great bulk of these large groups of birds and of several other less numerous though equally distinct families, is essentially neotropical.

Nor must it be supposed that we are yet by any means fully acquainted with the riches of the neotropical region. The active ornithologists of the day are making continual additions to the long list—chiefly through the exertions of collectors in various parts of the Andean Chain, where almost every valley appears to contain distinct species of birds. At a recent meeting of the Zoological Society, twenty-four new species of birds (several belonging to new genera) were described from a single district in Peru, and Mr. Gould is constantly recording additions to the long series of humming-birds which he has so admirably monographed. Besides this, the anatomy and osteology of the greater number of exotic birds is almost utterly unknown, so that there is ample work in the neotropical region alone for many future generations of ornithologists.

The two collections upon which the "Nomenclator" has been principally based are those of Mr. Sclater and of Messrs. Salvin and Godman. The former of these contains an unrivalled series of the American species of the great order Passeres, and a set of representatives of the other higher orders, down to the end of the parrots—altogether about 7,000 specimens. The latter collection is still larger and more general, embracing the whole series of American birds. It is especially rich in Central American forms, the owners having themselves visited several districts of the Central American Republics, and employed private collectors in other districts for the enrichment of their cabinets.

The "Nomenclator" gives us a summary of all the species represented in these two great collections, and of other species examined by the authors, but of which they have not yet succeeded in obtaining specimens.

In an appendix are added characters of nine new genera, and of thirty-one new species, founded on specimens contained in one or other of the above-mentioned collections.

OUR BOOK SHELF

The Mishmee Hills; an Account of a Journey made in an Attempt to penetrate Thibet from Assam to open new Routes for Commerce. By T. T. Cooper, F.R.G.S., Acting Political Agent at Bhamo. (London: Henry S. King and Co., 1873.)

MR. COOPER is already well known as an enterprising traveller and delightful story-teller through his "Travels of a Pioneer of Commerce in Pig-tail and Petticoats;" the present narrative is one of the most attractive published for a long time; it is one of the few books now published one feels inclined to read through at a sitting. Mr. Cooper tells his story without apparent effort, and in simple, unaffected style. For many centuries China has had the monopoly of supplying the Thibetans with tea, of which they are most extensive consumers. The Lamas of Thibet have the exclusive privilege of retailing this tea, and both they and the Chinese naturally do all in their power to prevent the possibility of any rivalry in the lucrative trade. It was on this account that Mr. Cooper was prevented from completing his intended journey from Shanghai overland to India. In the present work the author describes an attempt which he made to penetrate into Thibet from the Indian side, for the purpo e of discovering whether it would not be possible to open up a way for the introduction into that country of the abundant produce of the Assam tea-plantations. He proceeded from Calcutta to Sudiya, on the north-east frontier of Assam, from which, after making all due preparations, he set out on his adventurous journey in the latter part of 1869. Notwithstanding that Mr. Cooper was accompanied by a Khamtee chief, Chowsam—a fine manly fellow—who knew the country well, and was feared and respected by the people through whose country Mr. Cooper had to pass, the latter, amid great hardships, succeeded in penetrating north-eastward along the Brahmapootra, only about 100 miles, when, through the determined opposition of the Thibetan officials, he was compelled to turn back. No doubt Mr. Cooper failed in accomplishing the object on which he had set his heart, but his journey has been the means of giving to the world a book full of interesting information about the peoples and the countries where he sojourned, both in Assam and the districts just beyond its north-eastern frontier. The book contains a great deal of information on the present and past condition of Assam and the Assamese, and much information on the state of the tea-cultivation in that country. Mr. Cooper is particularly observant of men and manners, and most readers will find in his book a great deal that is quite new concerning the small tribes that live along the route by which he attempted, in the interest of commerce, to enter Thibet; his description of the Khamtees is especially interesting. Mr. Cooper does not pretend to give any scientific record of the natural history of the country through which he passed, though he makes occasional observations that may interest naturalists. The following description of the land-leeches which pestered him during his journey, seems to us particularly interesting:—

"Of all the hardships and unpleasant sensations experienced in the Assam jungle none have left a more disagreeable recollection than the attacks of land-leeches. Often, on sitting down, I could count a dozen of these little animals hurrying from all directions to their prey. In length they are about an inch, while their thickness does not exceed that of an ordinary sewing needle. Their mode of progression is curious in the extreme. Fixing one extremity by means of its bell-shaped sucker firmly on a leaf or on the ground, the leech curves itself into an arch, the other end is then advanced till the creature resembles a loop, again to expand into an arch, but the movement is quicker than words can describe it; the rapidity with which they thus progress along is quite startling. As they occasionally rear themselves perpendicularly and sway about from side to side, taking a survey round them in quest of prey, the observer cannot fail to conceive a dread of the bloodthirsty little creatures. They exercised quite a fascination over me. I could never resist watching them whenever I took a seat. Their power of scent was evidently keen. At first they would hold themselves erect, then suddenly, as though they had just discovered my whereabouts, they would throw themselves forward and with quick eager strides make towards my unfortunate body, and it was a long time before I could restrain a shudder at their approach, but use does wonders, and at last I used to flip them off my clothes and hands, Khamtee fashion, with great indifference. There are several species of leeches in Assam, but I have only come in contact with three kinds: the common brown one, just described; the red, or hill-leech, which is larger than the former and of a light red colour, inflicting a venomous, though not dangerous, bite; and the hair-leech, so called by the Khamtees from its great length and extreme tenuity. This last description of leech lies in wait in the grass, and as animals feed it enters the nostrils and fixes itself firmly in the interior, where it takes up permanent quarters, causing the poor beasts great irritation. It seems to inflict itself entirely on animals, which is fortunate, or man would suffer greatly from this scourge of the jungle."

Mr. Cooper has done well in telling the world the story of his travels.

Transactions of the Albany Institute, vol. vii. (Albany, U.S., 1872.)

THIS institution is one of the oldest of its kind in America, having been originally founded upwards of eighty years ago, just after the conclusion of the American War of Independence. At present it is one of the most comprehensive and active of the American societies, its sphere of work embracing all departments of literature and science. In an eloquent annual address, which is the first paper in this volume, Orlando Meads, one of the oldest members of the Institute, sketches its history, and gives reminiscences of some of the most eminent men who have been connected with the Society, including several who have left their mark on the country. A characteristic feature of this volume is the reports of what has been done during the year, both in America and Europe, in the various divisions of science and literature, the institution being divided into three departments—Physical Sciences and the Arts, Natural History, and History and General Literature, and these again into a number of classes. Thus we have in the present volume, reports on botany, zoology, chemistry, and general literature. Of the papers in this volume we may notice one On Nitro-glycerine, as used in the construction of the Hoosac Tunnel, by Prof. G. M. Mowbray. The author traces the history of the dangerous article, gives an account of his own investigations regarding it, and describes the method in which it was used in boring the Hoosac tunnel.—On certain new Phenomena in Chemistry, by Verplanck Colvin, describes some very remarkable experiments in amalgamation made by the author. From Newton to Kirchoff, by Dr. L. C. Cooley, traces in an interesting way the progress of research on Light during the period indicated; and in Researches in the Theory and Calculus of Operations, by J. A. Paterson, we have a most elaborate and intricate investigation on the theory of the actions of various forces of Nature. Mr. C. H. Peck contributes a Synopsis of New York Uncinulæ.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Microscopic Examination of Air

IN support of the conclusions arrived at by Mr. Douglas Cunningham, of Calcutta, in his "Microscopic Examinations of Air" (NATURE, vol. ix. p. 330), and in illustration of the method which he employed, perhaps I may be allowed to describe some observations of the same kind which I made three years ago but have not had leisure to continue or prepare for publication.

A sentence in Dr. Parkes' "Manual of Hygiene," alluding to the importance of minute examination of the air, turned my thoughts in that direction. The instrument which I constructed for the purpose was contrived after the manner of a weathercock, presenting the wide mouth of a funnel to the wind, while the tube of the funnel was bent upwards and had an orifice about 1-20th of an inch in diameter. Close above this orifice was placed a glass slide, held by springs and bearing a drop of glycerine on its lower surface. The tube and glass slide were protected by a roof and two cheek-boards, which formed the vane of the weather-cock. The glass slide was so placed that the current of air issuing from the narrow orifice of the bent tube, under pressure of the wind on the wide mouth of the funnel, impinged on the centre of the drop of glycerine, and a large proportion of any solid matters carried by the air was caught on the glycerine. After a day or two, according to the weather, the slide was removed, a thin disk of glass was placed on the glycerine-drop, and the contents were then examined under the microscope, a duplicate slide being left in the aeroscope for the next observation.

This instrument depended for its function on the wind. If there was no wind, there was no current through the tube, and nothing was caught on the glycerine; but in general there was wind enough, and the captures were ample, often embarrassing by their multitude. The observations were mostly made in the neighbourhood of London, at the Greenwich Observatory. The nature of the captures varied according to the direction and velocity of the wind, the state of the weather, and the season of the year. A north-west wind, blowing over London, brought soot and globules of coal-tar, textile fibres, nondescript *débris*, a few vegetable spores, now and then an epithelial scale or two, always a number of half-cooked starch-grains (identified by their reaction with iodine and by traces of concentric lamination giving a black cross with the polariscope), and sometimes microscopic bread-crumbs (half-cooked starch-grains in meshes of gluten). The starch-grains were the most constant capture of all, in all seasons and for all directions of wind. They seem to be very durable. (If I remember rightly, M. Pouchet found starch-grains in all specimens of dust, even the most ancient, obtained from the neighbourhood of human dwellings.) A southerly wind, blowing from the country, brought a great variety of vegetable spores and pollen-grains and *débris*, with a smaller proportion of matters characteristic of town air. The size and quantity of the captures depended mainly on the velocity of the wind. Once or twice a strong wind swept a living acarus, or an entomostracan, or the shell of a diatom into the glycerine. In dry windy weather a quantity of siliceous sand was caught, which gave trouble by tilting the disk when in preparation for the microscope, and the larger grains had to be removed with the point of a needle.

The most interesting variation in the character of the organic captures was that which depended on the season of the year. In January and February scarcely anything was found (besides *débris* and inorganic matter) but a few fragments of mycelium of some fungus; but with the first fine weather in March the glycerine began to yield good returns. Spherical grains of poplar pollen were caught in large numbers, thirty or forty in a single drop, though the nearest poplar tree was a quarter of a mile distant. These were soon followed by the triangular pollen of birch and hazel—trees depending, like poplar, on the agency of the wind for fertilisation. From this time onward, through spring and summer, a great number and variety of pollen grains were caught. Cryptogamic cells increased in number through the summer, and reached their maximum in the autumn, when brown septate spores and others of various kinds, which my imperfect knowledge did not enable me to identify, appeared in abundance. If left for some days, they began to germinate. Towards winter their number diminished, the latest being minute dark brown oval spores of some species of agaricus (?). The winter months were comparatively barren.

I did not find any Bacteria, but there were numbers of excessively minute particles, of which I could not tell the nature. Once, after leaving the aeroscope for several days, I found the glycerine swarming with a minute *torula* which had evidently multiplied in that pabulum. In fact the glycerine was fermenting.

Among these facts, the only one which seems to have any bearing on the question of the propagation of infectious diseases is the great prevalence of cryptogamic spores in the air in autumn, when those diseases are especially rife.

To avoid fallacy in the results obtained, I used to place two drops of glycerine on the same slide, but only directed the air-current against one of them; both were examined under the microscope, and the difference credited to the air. By using glycerine that had been boiled with carmine, many of the organic captures were made more distinct: the nuclei of epithelial scales and of many other cells were brightly stained by the carmine. Glycerine had the disadvantage of absorbing moisture in damp weather and swelling to an inconvenient bulk. At such times I used oil instead, with good effect. My plan of examination was to sweep the whole disk in successive parallel zones, by the aid of mechanical stage-movement, and make record of every organic body that could be recognised. Such as I had not seen before were sketched with pen and ink and coloured chalk in a book devoted to that purpose.

It will be seen that my observations entirely support Mr Cunningham's, as to the abundant presence of living spores in the air. I was satisfied that this branch of research, in the hands of one thoroughly familiar with these microscopic forms, would lead to results of great interest, and I heartily congratulate Mr. Cunningham on the valuable work which he has produced.

HUBERT AIRY

Animal Locomotion

MR. WALLACE'S last letter seems to call for a word of explanation from me. I did not refer to the up stroke of the bird's wing because this was not the point in dispute. But in reply to Mr. Wallace's latest stricture—that I appear "to ignore the great downward reaction, added to gravitation, during every up stroke"—I would say (1) that the downward reaction is not great, (*a*) because, as Mr. Wallace has himself observed, of the valvular action of the feathers; (*b*) because of the convex form of the upper surface of the wing; and (*c*) in some cases, because the wing is less expanded in the up stroke. (2) As to the effect of gravitation, this was already allowed for in determining the resultant motion consequent on the down stroke, and must not be reckoned twice. Just as with an arrow shot from a bow, so with the bird; the motion consequent on the down stroke lasts long enough for the wings to be raised before it is spent. Mr. Wallace is certainly right in saying that the down stroke should counteract the downward reaction of the up stroke, but this downward reaction being slight cannot require "a highly-inclined upward motion," and what is more, it cannot require that the under surface of the wing should be directed forwards as Dr. Pettigrew asserts.

Again, I do not say the movement of the wing as a whole is downward and backward, but that the action of its surface is in that direction. The Duke of Argyll is no doubt correct in maintaining that the wing as a whole moves in a perpendicular line, or perhaps with a slight forward overlap.

I cordially agree with Mr. Wallace that the matter is not to be settled by "discussing theoretically, but by observation and experiment;" still the elementary principles of mechanics may surely be heard in evidence without disadvantage even at the outset of the inquiry.

JAMES WARD

Trinity College, Cambridge, March 30

Rudimentary Organs

IN a former communication (NATURE, vol. ix. p. 361) I promised to advance what seems to me a probable cause—additional to those already known—of the reduction of useless structures. As before stated, it was suggested to me by the penetrating theory proposed by Mr. Darwin (NATURE, vol. viii. pp. 432 and 505), to which, indeed, it is but a supplement. Epitomising Mr. Darwin's conception as to the dwarfing influence of impoverished conditions, progressively reducing the average size of a useless structure, by means of free intercrossing; the present cause may be defined as the mere cessation of the selective influence from changed condition of life.

Suppose a structure to have been raised by natural selection from 0 to average size 100, and then to have become wholly useless. The selective influence would now not only be withdrawn, but reversed; for, through Economy of Growth—understanding by this term both the direct and the indirect influence of natural selection*—it would rigidly eliminate the variations 101, 102, 103, &c., and favour the variations 99, 98, 97, &c. For the sake of definition we shall neglect the influence of Economy acting below 100, and so isolate the effects due to the mere withdrawal of Selection. By the condition of our assumption, all variations above 100 are eliminated, while below 100 indiscrimi-

* See former communication, NATURE, vol. ix. p. 361.

nate variation is permitted. Thus, the selective premium upon variation 99 being no greater than that upon 98, 98 would have as good a chance of leaving offspring (which would inherit and transmit this variation) as would 99: similarly, 97 would have as good a chance as 98, and so on. Now there is thus a much greater chance of variations being perpetuated at or below 99, than at or above 100; for at 100 the hard line of Selection (or Economy) is fixed, while there is no corresponding line below 100. The consequence of free intercrossing would therefore be to reduce the average from 100 to 99. Simultaneously, however, with this reducing process, other variations would be surviving below 99, in greater numbers than above 99; consequently the average would next become reduced to 98. There would thus be "two operations going on side by side—the one ever destroying the symmetry of distribution" round the average, "and the other ever tending to restore it." It is evident, however, that the more the average is reduced by this process of indiscriminate variation, the less chance there remains for its further reduction. When, for instance, it falls to 90, there are (numerically, though not actually, because of Inheritance) 89 to 9 in favour of diminution; but, when it falls to 80, there are only 79 to 19 in such favour. Thus (theoretically) the average would continue to diminish at a slower and slower rate, until it comes to 50, where, the chances in favour of increase and of diminution being equal, it would remain stationary.

Having thus, for the sake of clearness, considered this principle apart, let us now observe the effect of superadding to it the influence of the Economy of Growth—a principle with which its action must always be associated. Briefly, as this influence would be that of continually favouring the variations on the side of diminution, the effect of its presence would be that of continuously preventing the average from becoming fixed at 50, 40, 30, &c. In other words, the "hard line of Selection," which was originally placed at 100, would now become progressively lowered through 90, 80, 70, &c.; always allowing indiscriminate variation below the barrier, but never above it.

It will be understood that by "cessation of selection from changed conditions of life" I mean a change *of any kind* which renders the affected organ superfluous. Take, for example, the exact converse of Mr. George Darwin's illustration, by supposing a herd of cattle to migrate from a small tract of poor pasture to a large tract of rich. Segregation would ensue, the law of battle would become less severe, while variation would be promoted in a cumulative manner by the increase of food. The young males with shorter horns would thus have as good a chance of leaving progeny as "their longer-horned brothers," and the average length would gradually diminish as in the other case. Of course, as the predisposing cause of impoverished nutrition would now be absent, the reducing process would take place at a slower rate. Moreover, it is to be remarked that this principle differs in an important particular from that enunciated by Mr. Darwin, in that it could never reduce an organ much below the point at which the Economy of Growth (together with Disuse) ceases to act. For, returning to our numerical illustration, suppose this point to be 6, the average would eventually become fixed at 3.

That the principle thus explained has a real existence we may safely conclude, theoretical considerations apart, from the analogy afforded by our domestic races; for nothing is more certain to breeders than the fact that neglect causes degeneration, even though the strain be kept isolated. It will be observed that, if this principle has a real existence, it is of considerable importance, theoretically, since it must act, to a greater or less extent, in all cases where Disuse and the Economy of Growth are in operation; and although in the initial stages of reduction, when the purchase, so to speak, of the last-named principle is great, its influence would be comparatively trivial, this influence would be more and more felt the smaller the organ became—*i.e.*, the nearer the point at which the Economy of Growth ceases to act. The Cessation of Selection should therefore be regarded as a reducing cause, which co-operates with other reducing causes in all cases, and which is of special importance as an accelerating agent when the influence of the latter becomes feeble.

GEORGE J. ROMANES

Lakes with two Outfalls

On June 22, 1863, the late Captain Speke published his map, giving (on native authority) *four* outlets from Lake Victoria Nyanza, converging to *one* valley or water-flow—the Nile.

On June 27 and on July 20 I wrote to the *Athenæum*:—"I think that this native information will prove to be erroneous;" that I thought "that no lake can have more than one outlet;" and I added, "May I lay the question as to the matter of fact before the readers of the *Athenæum*?" In reply, the Black Loch in Dumfriesshire was stated to have *two* outlets to *two* distinct valleys or water-flows—one to the Nith, the other to the Ayr. The Loch, however, has but one outlet, and that *artificial*. The water-parting has been cut through by man—a mill-lead made to Lord Bute's Borland mill, and the one outlet is an iron sluice in a stone dam. All this is beautifully shown in Sir Henry James's admirable 25-inch Ordnance Maps.

Dr. Bryce ("Geology of Arran," 3rd edition, p. 3) says that Loch-an-Davie has two outlets to two different valleys. It has, however, but one outlet, to the south—to Glen Iorsa, as I stated in the *Athenæum*, July 22, 1865. The new inch Ordnance Map of Arran gives one outlet, but unfortunately to the north, instead of to the south. I will not refer to my letter on the two outlets to two valleys from the Norwegian Lesjeskaugen Lake, which you did me the honour to publish last September, and with which Prof. Stanley Jevons agreed. But I quote the above cases to show that even the highest authorities make mistakes as regards lakes and their outlets. I cannot, however, suppose any mistake in Prof. Bell's account of the two outlets to two valleys from Shoal Lake, published in NATURE, vol. ix. p. 363, by Prof. Dawson. I would then, in deference to these authorities, modify my dictum by saying, that if by a rare possibility a lake may be found to exist on a water-parting having at opposite ends two outlets to two different valleys, I should still doubt the possibility of a lake at its one lower end having a multiplicity of outlets converging to one valley or water-flow, as in the case of the Victoria Nyanza. And this owing to the extreme improbability that the erosion at each outlet should continue at precisely the same rate.

The outlet of every lake in the wide, wide world is always being lowered from erosion, as are valleys themselves. Valleys exist only in the dissolution of hills. They are mere water-flows. They are the perpetually changing effects of atmospheric disintegration, and the erosion of rain and rivers, and consequently every water-parting is a valley-parting.

Alresford, March 14 GEORGE GREENWOOD

A Beech pierced by a Thorn Plant

On the road from this to Belfast there is a thorn hedge with beech trees at intervals, and thorn plants have grown right through the middle of the trunks of two of the beeches. I do not know whether this is sufficiently uncommon to be worth mentioning in NATURE. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, co. Antrim

KINETIC THEORY OF THE DISSIPATION OF ENERGY

In abstract dynamics an instantaneous reversal of the motion of every moving particle of a system causes the system to move backwards, each particle of it along its old path, and at the same speed as before when again in the same position—that is to say, in mathematical language, any solution remains a solution when t is changed into $-t$. In physical dynamics, this simple and perfect reversibility fails on account of forces depending on friction of solids; imperfect fluidity of fluids; imperfect elasticity of solids; inequalities of temperature and consequent conduction of heat produced by stresses in solids and fluids; imperfect magnetic retentiveness; residual electric polarisation of dielectrics; generation of heat by electric currents induced by motion; diffusion of fluids, solution of solids in fluids, and other chemical changes; and absorption of radiant heat and light. Consideration of these agencies in connection with the all-pervading law of the conservation of energy proved for them by Joule, led me twenty-three years ago to the theory of the dissipation of energy, which I communicated first to the Royal Society of Edinburgh in 1852, in a paper entitled

"On a Universal Tendency in Nature to the Dissipation of Mechanical Energy.

The essence of Joule's discovery is the subjection of physical phenomena to dynamical law. If, then, the motion of every particle of matter in the universe were precisely reversed at any instant, the course of nature would be simply reversed for ever after. The bursting bubble of foam at the foot of a waterfall would reunite and descend into the water: the thermal motions would reconcentrate their energy and throw the mass up the fall in drops reforming into a close column of ascending water. Heat which had been generated by the friction of solids and dissipated by conduction, and radiation with absorption, would come again to the place of contact and throw the moving body back against the force to which it had previously yielded. Boulders would recover from the mud the materials required to rebuild them into their previous jagged forms, and would become reunited to the mountain peak from which they had formerly broken away. And if also the materialistic hypothesis of life were true, living creatures would grow backwards, with conscious knowledge of the future, but no memory of the past, and would become again unborn. But the real phenomena of life infinitely transcend human science, and speculation regarding consequences of their imagined reversal is utterly unprofitable. Far otherwise, however, is it in respect to the reversal of the motions of matter uninfluenced by life, a very elementary consideration of which leads to the full explanation of the theory of dissipation of energy.

To take one of the simplest cases of the dissipation of energy, the conduction of heat through a solid—consider a bar of metal warmer at one end than the other and left to itself. To avoid all needless complication, of taking loss or gain of heat into account, imagine the bar to be varnished with a substance impermeable to heat. For the sake of definiteness, imagine the bar to be first given with one half of it at one uniform temperature, and the other half of it at another uniform temperature. Instantly a diffusing of heat commences, and the distribution of temperature becomes continuously less and less unequal, tending to perfect uniformity, but never in any finite time attaining perfectly to this ultimate condition. This process of diffusion could be perfectly prevented by an army of Maxwell's "intelligent demons"* stationed at the surface, or interface as we may call it with Prof. James Thomson, separating the hot from the cold part of the bar. To see precisely how this is to be done, consider rather a gas than a solid, because we have much knowledge regarding the molecular motions of a gas, and little or no knowledge of the molecular motions of a solid. Take a jar with the lower half occupied by cold air or gas, and the upper half occupied with air or gas of the same kind, but at a higher temperature, and let the mouth of the jar be closed by an air-tight lid. If the containing vessel were perfectly impermeable to heat, the diffusion of heat would follow the same law in the gas as in the solid, though in the gas the diffusion of heat takes place chiefly by the diffusion of molecules, each taking its energy with it, and only to a small proportion of its whole amount by the interchange of energy between molecule and molecule; whereas in the solid there is little or no diffusion of substance, and the diffusion of heat takes place entirely, or almost entirely, through the communication of energy from one molecule to another. Fourier's exquisite mathematical analysis expresses perfectly the statistics of the process of diffusion in each case, whether it be "conduction of heat," as Fourier and his followers have called it, or the diffusion of substance in fluid masses (gaseous or liquid) which Fick showed to be subject to Fourier's formulæ. Now, suppose the weapon of the ideal army to be a club, or, as it were, a molecular cricket-bat; and suppose for convenience the mass of each demon with his weapon to be several times greater than that of a molecule. Every time he strikes a molecule he is to send it away with the same energy as it had immediately before. Each demon is to keep as nearly as possible to a certain station, making only such excursions from it as the execution of his orders requires. He is to experience no forces except such as result from collisions with molecules, and mutual forces between parts of his own mass, including his weapon: thus his voluntary movements cannot influence the position of his centre of gravity, otherwise than by producing collision with molecules.

The whole interface between hot and cold is to be divided into small areas, each allotted to a single demon. The duty of each demon is to guard his allotment, turning molecules back or allowing them to pass through from either side, according to certain definite orders. First, let the orders be to allow no molecules to pass from either side. The effect will be the same as if the interface were stopped by a barrier impermeable to matter and to heat. The pressure of the gas being, by hypothesis, equal in the hot and cold parts, the resultant momentum taken by each demon from any considerable number of molecules will be zero; and therefore he may so time his strokes that he shall never move to any considerable distance from his station. Now, instead of stopping and turning all the molecules from crossing his allotted area, let each demon permit a hundred molecules chosen arbitrarily to cross it from the hot side; and the same number of molecules, chosen so as to have the same entire amount of energy and the same resultant momentum, to cross the other way from the cold side. Let this be done over and over again within certain small equal consecutive intervals of time, with care that if the specified balance of energy and momentum is not exactly fulfilled in respect to each successive hundred molecules crossing each way, the error will be carried forward, and as nearly as may be corrected, in respect to the next hundred. Thus, a certain perfectly regular diffusion of the gas both ways across the interface goes on, while the original different temperatures on the two sides of the interface are maintained without change.

Suppose, now, that in the original condition the temperature and pressure of the gas are each equal throughout the vessel, and let it be required to disequalise the temperature but to leave the pressure the same in any two portions A and B of the whole space. Station the army on the interface as previously described. Let the orders now be that each demon is to stop all molecules from crossing his area in either direction except 100 coming from A, arbitrarily chosen to be let pass into B, and a greater number, having among them less energy but equal momentum, to cross from B to A. Let this be repeated over and over again. The temperature in A will be continually diminished and the number of molecules in it continually increased, until there are not in B enough of molecules with small enough velocities to fulfil the condition with reference to permission to pass from B to A. If after that no molecule be allowed to pass the interface in either direction, the final condition will be very great condensation and very low temperature in A; rarefaction and very high temperature in B; and equal temperature in A and B. The process of disequalisation of temperature and density might be stopped at any time by changing the orders to those previously specified (2), and so permitting a certain degree of diffusion each way across the interface while maintaining a certain uniform difference of temperatures with equality of pressure on the two sides.

If no selective influence, such as that of the ideal "demon," guides individual molecules, the average result of their free motions and collisions must be to equalise the distribution of energy among

* The definition of a "demon," according to the use of this word by Maxwell, is an intelligent being endowed with free will, and fine enough tactile and perceptive organisation to give him the faculty of observing and influencing individual molecules of matter.

them in the gross; and after a sufficiently long time from the supposed initial arrangement the difference of energy in any two equal volumes, each containing a very great number of molecules, must bear a very small proportion to the whole amount in either; or, more strictly speaking, the probability of the difference of energy exceeding any stated finite proportion of the whole energy in either is very small. Suppose now the temperature to have become thus very approximately equalised at a certain time from the beginning, and let the motion of every particle become instantaneously reversed. Each molecule will retrace its former path, and at the end of a second interval of time, equal to the former, every molecule will be in the same position, and moving with the same velocity, as at the beginning; so that the given initial unequal distribution of temperature will again be found, with only the difference that each particle is moving in the direction reverse to that of its initial motion. This difference will not prevent an instantaneous subsequent commencement of equalisation, which, with entirely different paths for the individual molecules, will go on in the average according to the same law as that which took place immediately after the system was first left to itself.

By merely looking on crowds of molecules, and reckoning their energy in the gross, we could not discover that in the very special case we have just considered the progress was towards a succession of states in which the distribution of energy deviates more and more from uniformity up to a certain time. The number of molecules being finite, it is clear that small finite deviations from absolute precision in the reversal we have supposed would not obviate the resulting disequalisation of the distribution of energy. But the greater the number of molecules, the shorter will be the time during which the disequalising will continue; and it is only when we regard the number of molecules as practically infinite that we can regard spontaneous disequalisation as practically impossible. And, in point of fact, if any finite number of perfectly elastic molecules, however great, be given in motion in the interior of a perfectly rigid vessel, and be left for a sufficiently long time undisturbed except by mutual impacts and collisions against the sides of the containing vessel, it must happen over and over again that (for example) something more than nine-tenths of the whole energy shall be in one half of the vessel, and less than one-tenth of the whole energy in the other half. But if the number of molecules be very great, this will happen enormously less frequently than that something more than 6-10ths shall be in one half, and something less than 4-10ths in the other. Taking as unit of time the average interval of free motion between consecutive collisions, it is easily seen that the probability of there being something more than any stated percentage of excess above the half of the energy in one half of the vessel during the unit of time, from a stated instant, is smaller the greater the dimensions of the vessel and the greater the stated percentage. It is a strange but nevertheless a true conception of the old well-known law of the conduction of heat to say that it is very improbable that in the course of 1,000 years one half the bar of iron shall of itself become warmer by a degree than the other half; and that the probability of this happening before 1,000,000 years pass is 1,000 tines as great as that it will happen in the course of 1,000 years, and that it certainly will happen in the course of some very long time. But let it be remembered that we have supposed the bar to be covered with an impermeable varnish. Do away with this impossible ideal, and believe the number of molecules in the universe to be infinite; then we may say one half of the bar will never become warmer than the other, except by the agency of external sources of heat or cold. This one instance suffices to explain the philosophy of the foundation on which the theory of the dissipation of energy rests.

Take however another case in which the probability may be readily calculated. Let a hermetically-sealed glass jar of air contain 2,000,000,000,000 molecules of oxygen, and 8,000,000,000,000 molecules of nitrogen. If examined any time in the infinitely distant future, what is the number of chances against one that all the molecules of oxygen and none of nitrogen shall be found in one stated part of the vessel equal in volume to 1-5th of the whole? The number expressing the answer in the Arabic notation has about 2,173,220,000,000 of places of whole numbers. On the other hand the chance against there being exactly 2-10ths of the whole number of particles of nitrogen, and at the same time exactly 2-10ths of the whole number of particles of oxygen in the first specified part of the vessel is only 4021×10^9 to 1.

[*Appendix.—Calculation of Probability respecting Diffusion of Gases.*]

For simplicity I suppose the sphere of action of each molecule to be infinitely small in comparison with its average distance from its nearest neighbour: thus, the sum of the volumes of the spheres of action of all the molecules will be infinitely small in proportion to the whole volume of the containing vessel. For brevity, space external to the sphere of action of every molecule will be called free space: and a molecule will be said to be in free space at any time when its sphere of action is wholly in free space; that is to say, when its sphere of action does not overlap the sphere of action of any other molecule. Let A, B denote any two particular portions of the whole containing vessel, and let a, b be the volumes of those portions. The chance that at any instant one individual molecule of whichever gas shall be in A is $\frac{a}{a+b}$, however many or few other molecules there may be in A at the same time; because its chances of being in any specified portions of free space are proportional to their volumes; and, according to our supposition, even if all the other molecules were in A, the volume of free space in it would not be sensibly diminished by their presence. The chance that of n molecules in the whole space there shall be i stated individuals in A, and that the other $n - i$ molecules shall be at the same time in B, is

$$\left(\frac{a}{a+b}\right)^i \left(\frac{b}{a+b}\right)^{n-i} \text{ or } \frac{a^i b^{n-i}}{(a+b)^n}$$

Hence the probability of the number of molecules in A being exactly i, and in B exactly $n - i$, irrespectively of individuals, is a fraction having for denominator $(a + b)^n$, and for numerator the term involving $a^i b^{n-i}$ in the expansion of this binomial; that is to say it is—

$$\frac{n(n-1)\ .\ .\ .\ .\ (n-i+1)}{1.2 \qquad\qquad i} \left(\frac{a}{a+b}\right)^i \left(\frac{b}{a+b}\right)^{n-i}$$

If we call this T_i we have

$$T_{i+1} = \frac{n-i}{i+1}\frac{a}{b}\ T_{i+}$$

Hence T_i is the greatest term if i is the smallest integer which makes

$$\frac{n-i}{i+1} < \frac{b}{a}$$

this is to say, if i is the smallest integer which exceeds

$$n\frac{a}{a+b} - \frac{b}{a+b}$$

Hence if a and b are commensurable the greatest term is that for which

$$i = n\frac{a}{a+b}$$

To apply these results to the cases considered in the preceding article, put in the first place

$$n = 2 \times 10^{12}$$

this being the number of particles of oxygen; and let $i = n$. Thus, for the probability that all the particles of oxygen shall be in A, we find

$$\left(\frac{a}{a+b}\right)^{8 \times 10^{12}}$$

Similarly, for the probability that all the particles of nitrogen are in the space B, we find

$$\left(\frac{b}{a+b}\right)^{8 \times 10^{12}}$$

Hence the probability that all the oxygen is in A and all the nitrogen in B is

$$\left(\frac{a}{a+b}\right)^{2 \times 10^{12}} \times \left(\frac{b}{a \times b}\right)^{8 \times 10^{12}}.$$

Now by hypothesis

$$\frac{a}{a+b} = \frac{2}{10}$$

and therefore

$$\frac{b}{a+b} = \frac{8}{10}$$

hence the required probability is

$$\frac{2^{26 \times 10^{12}}}{10^{10^{13}}}$$

Call this $\frac{1}{N}$, and let log denote common logarithm. We have $\log N = 10^{13} - 26 \times 10^{12} \times \log. 2 = (10 - 26 \log. 2) \times 10^{12} = 2173220 \times 10^{6}$. This is equivalent to the result stated in the text above. The logarithm of so great a number, unless given to more than thirteen significant places, cannot indicate more than the number of places of whole numbers in the answer to the proposed question, expressed according to the Arabic notation.

The calculation of T_i when i and $n - i$ are very large numbers is practicable by Stirling's Theorem, according to which we have approximately

$$1.2 \ldots i = i^{i+\frac{1}{2}} e^{-i} \sqrt{2\pi}$$

and therefore

$$\frac{n(n-1)\ldots(n-i+1)}{1.2 \ldots i} = \frac{n^{n+\frac{1}{2}}}{\sqrt{2\pi}\, i^{(i+\frac{1}{2})}(n-i)^{n}}$$

Hence for the case

$$i = n\frac{a}{a+b}$$

which, according to the preceding formulæ, gives T_i its greatest value, we have

$$T_i = \frac{1}{\sqrt{2\pi nef}}$$

where

$$e = \frac{a}{a+b} \text{ and } f = \frac{b}{a+b}$$

Thus, for example, let $n = 2 \times 10^{12}$;

$$e = \cdot 2,\ f = \cdot 8$$

we have

$$T_i = \frac{1}{800000\sqrt{\pi}} = \frac{1}{1418000}$$

This expresses the chance of there being 4×10^{11} molecules of oxygen in A, and 16×10^{11} in B. Just half this fraction expresses the probability that the molecules of nitrogen are distributed in exactly the same proportion between A and B, because the number of molecules of nitrogen is four times greater than of oxygen.

If n denote the molecules of one gas, and n' that of the molecules of another, the probability that each shall be distributed between A and B in the exact proportion of the volume is

$$\frac{1}{2\pi ef\sqrt{nn'}}$$

The value for the supposed case of oxygen and nitrogen is

$$\frac{1}{2\pi \times \cdot 16 \times 4 \times 10^{12}} = \frac{1}{4021 \times 10^{9}}$$

which is the result stated at the conclusion of the text above.

WILLIAM THOMSON

LIVINGSTONE'S WORK IN AFRICA

THE daily papers have published some extracts from a letter of the late Dr. Livingstone to Mr. H. M. Stanley, which have been kindly furnished by the enterprising proprietor of the *New York Herald;* we reproduce here so much of the letter as bears on the geographical work done by Livingstone.

"The Chambezi was crossed long ago by the Portuguese, who have thus the merit of its discovery in modern times. The similarity of names led to its being put down in maps as 'Zambesi' (eastern branch) and I rather stupidly took the error as having some sort of authority. Hence my first crossing it was as fruitless as that of the Portuguese. It took me twenty-two months to eliminate this error.

"The Cazembe who was lately killed was the first who gave me a hint that Chambezi was one of a chain of rivers and lakes which probably forms the Nile; but he did it in rather a bantering style that led me to go back to the head waters again and see that it was not the mere 'chaff' of a mighty potentate. There is Omar Island in the middle of Bangueldo, with 183° of sea horizon around. The natives, slowly drawing the hand around, said—'That is Chambezi flowing round all this space and forming Bangweolo before it winds round that headland and changes its name to Luapula.' That was the moment of discovery and not the mere crossing of a small river.

"The late Cazembe I found sensible and friendly. His empire has succumbed before a very small force of Arab slaves and Banyamwezi. Pereira, the first Portuguese who visited the Cazembe eighty years ago, said that he had 30,000 trained soldiers, sacrificed twenty human victims every day, and that the streets of his capital were watered daily. I thought that my late friend had 30,0(00), diminished by two 00's, and sacrificed five or six pots of pombe daily; but this may have been only a court scandal —the streets of his village were not made. So I was reminded of the famous couplet about the Scotch roads:—

"'If you had seen these roads before they were made,
You would lift up your hands and bless General Wade.'

"I have been the unfortunate means of demolishing two empires in Portuguese geography—the Cazembes and that of the Emperor Monomotapa. I found the last about ten days above Tette. He had too few men to make the show Cazembe did, but I learnt from some decent motherly-looking women attached to his Court Zembere (?) that he had 100 wives. I have wondered ever since and have been nearly dumfoundered with the idea of what a nuisance a man with 100 wives in England would be. It is awful to contemplate, and might be chosen as a theme for a Young Men's Debating Society. I wish someone would visit Mtesa, or Uganda, without Bombay as an interpreter. He (Bombay) is by no means a sound author. The King of Dahomey suffered eclipse after a common-sense visit, and we seldom hear any more of his atrocities. The mightiest African potentate and the most dreadful cruelties told of Africans owe a vast deal to the teller.

"You and I passed the islet Kasenge, where African mothers were said to sell their infants for a loin-cloth each. This story was made to fit into another nice little story of 'a mother bear' that refused to leave her young. A child that cuts its upper front teeth before the under is dreaded as unlucky and likely to bring death into the family. It is called an Arab child, and the first Arab who passes is asked to take it. I never saw a case, nor have the Arabs I have asked seen one either, but they have heard of its occurrence. The Kasenge story is, therefore, exactly like that of the Frenchman who asserted that the English were so fond of hanging themselves in November you might see them swinging on trees along the road. He may have seen one; I never did. English and American mothers have been guilty of deserting infants; but who would turn up the whites of his eyes and say, as our mothers at Kasenge did, these people are no better than, or not so good as, she-bears?

"This lake, so far as I have seen it, is surrounded by an extremely flat country, though all 4,000 ft. above the level of the sea. When first discovered I was without paper, but borrowed a little from an Arab, and sent a short account home. I had so much trouble from attendants that I took only the barest necessaries. Yet no sooner was the discovery announced at the coast than the official description was forthwith sent to the Bombay Government, that 'the lake is like Nyassa, Tanganyika, and the Albert Nyanza, overhung by high mountain slopes, which slope down to great plains, which, during the rainy season, become flooded, so that caravans march for days through water knee-deep seeking for higher ground on which to pass the night.'

"The only mountain slopes are ant-hills, some of them 20ft. high. They could scarcely be called high unless thought of as being built on the top of the 4,000 ft. These statements are equally opposed to the truth, as the Cazembe town is built on the banks of the Luapula.

"People having a crochet for map-making traced every step of the Portuguese slaving expeditions to Cazembe, and built the village in latitude 8° 43′ South—that is, in deep water, near the north end of Lake Moero, and over 50 miles from Luapula. I found it in latitude 9° 37′ South, and on the banks of a lagoon or loch, having no connection with Luapula, which river, however, falls six or seven miles west of the village of Moero.

"Now it is very unpleasant for me to expose any of these misstatements and so appear contradictious. But what am I to do? I was consulted by Sir Roderick Murchison as to this present expedition, and recommended the writer of the above as a leader. Sir Roderick afterwards told me that the offer was declined unless a good salary and a good position to fall back upon were added, as Speke and Grant had, on their pay and commission. He then urged the leadership on myself as soon as the work on which I was engaged should be published. My good, kind-hearted friend added, in a sort of pathetic strain, 'You will be the real discoverer of the source of the Nile.' I don't wish to boast of my good deeds, but I need not forget them."

SOUNDINGS IN THE PACIFIC

RECENT explorations in the Pacific Ocean indicate that its bed is singularly level. The soundings of the U.S. steamer *Tuscarora*, Capt. George T. Belknap, between Cape Flattery and Oonalaska, were described in NATURE, vol. viii. p. 150. Upon the conclusion of that cruise, which included also soundings from Cape Flattery to San Francisco, a month was spent in the latter harbour, and on December 5 a survey was begun between that port and San Diego on the same coast, especially between depths of 100 and 1,500 fathoms. The latter depth or a greater one is reached precipitately along the entire coast of California, at distances of 20 to 70 miles from shore. Off the Golden Gate, in the latitude of San Francisco Bay, at a distance of 30 miles, there is 100 fathoms; at 55 miles' distance, there is a sudden descent from 400 fathoms to a depth of two miles; at 100 miles out, 2,548 fathoms failed to reach bottom.

Soundings between San Diego, California, and Honolulu, Sandwich Islands, show that this part of the Pacific is a basin with precipitous sides and a comparatively level bottom. The distance between these points, surveyed by the *Tuscarora*, is 2,240 miles. The work was accomplished between January 6 and February 3, favourable weather being experienced during almost the entire voyage.

In the first 100 miles west from San Diego, there appear to be two valleys and two peaks. The first valley is from 622 to 784 fathoms depth; the first peak 445 fathoms, the second valley 955 fathoms, the second peak 566 fathoms. Thence a precipitous fall takes place, giving in lat. 31° 43′ N., long. 119° 28′ W., at 115 miles from San Diego, a depth of 1,915 fathoms. After that there is a gentle slope with comparatively unimportant interruptions, at the rate of three feet to the mile, to the point of greatest depth, 3,054 fathoms, at a distance of about 400 miles east of Honolulu. The sharpest elevation is a rise about midway between the United States and the Sandwich Islands, in lat. 26° 30′ N., long. 127° 37′ W., the highest portion of which is 2,159 fathoms below the surface. At the next cast of the lead, the valley to the west of this elevation took 2,650 fathoms. The fall of the side of the basin east of Honolulu is even more remarkable than the descent off the American coast. Fifty miles from Honolulu, soundings gave 498 fathoms; at 40 miles farther east, in lat. 21° 43′ N., long. 156° 21′ W., the depth was 3,023 fathoms. Between the last-mentioned point and that of greatest depth a hill rises, on whose summit there are only 2,488 fathoms of water.

These soundings coincide very nearly with the determinations of the depth of the Pacific made on theoretical grounds by the United States Coast Survey in 1854. Those calculations were based on the movements of tidal waves occasioned by earthquakes in Asia. The wave that reached San Francisco had a length of 210 to 217 miles, an oscillation of 35 minutes, and a velocity of 6·0 to 6·2 miles per minute. This would give a depth of 2,200 to 2,500 fathoms. Similar data with regard to the wave that reached San Diego (having a length of 186 to 192 miles) were calculated as giving an average depth of 2,100 fathoms. The average depth of the present soundings is about 2,400 fathoms.

The bottom is generally a soft, yellowish-brown ooze, better suited in this respect, as well as in being more level, than the route surveyed toward Oonalaska, for a telegraphic cable. Other considerations of an economic character, such as prospects of connection with other telegraph lines, may also serve to overbalance the shortness of the more northern route, and there is much better prospect of fair weather for laying a cable and keeping it in repair in the lower latitudes.

Surface-temperatures rose from 59° F. near San Diego, to 74° F. near Honolulu; temperatures at 105 fathoms between the same places rose from 50° F to 63° F. These, of course, indicate the equatorial current. At 300 fathoms the temperature was constant at 43° F. At bottom, the temperature was everywhere 35° F., except in a single instance where it was 1° colder. The uniformity of temperature below 1,600 fathoms was noticeable.

One wire has been used in all these soundings, which were made every 40 miles, and the apparatus still works excellently.

M. CHARLES SAINTE-CLAIRE DEVILLE'S WEATHER PROGNOSTICATIONS

THE prognostications delivered by M. Charles Sainte-Claire Deville, in his communication of March 2, before the French Institute, were wonderfully fulfilled, at least for Paris, the cold period having had its beginning on the 9th, and its end on the 13th, as was predicted. Public attention was all the more attracted because the cold was manifested by a heavy fall of snow, which was the first of the year. Having recently visited M. Ch. Sainte-Claire Deville, the learned physicist was kind enough to explain everything connected with his theories.

M. Ch. Sainte-Claire Deville has very often published similar prognostications which were always successful, but never in so striking a way. He has been a constant compiler of meteorological records for nearly twenty years; and being the Inspector-General of the French Meteorological Stations, as well as a member of the French Academy of Sciences, he has consequently at his command an immense number of trustworthy observations.

He has discovered that there is monthly a large thermometrical oscillation, which he calls dodecuple, from the

the Greek word δώδεκα, twelve; that dodecuple oscillation generally takes place in the second week of the month, but it is not equally marked every month, and besides it is not true to say that it is always exhibited by a depression of the mean temperature.

The November dodecuple oscillation decidedly exhibits a warming effect. February, March, and May have, on the contrary, a cooling effect. For centuries May and November were observed and noted as the "Saints de Glace" of the spring and Martinmas summer. But other oscillations, viz. February and March, which are generally very cold, were unnoticed.

The range of the oscillations, as well as their exact position *in time*, are different for different years, very probably because there is more than one single law in operation to produce them. Happily M. Charles Sainte-Claire Deville has discovered an indication which enables him to foresee which oscillations are to be the largest or the smallest.

Each dodecuple thermometrical oscillation is preceded by a similar dodecuple barometrical oscillation. The difference of time between both oscillations is variable, but the ordinary value is *five days*. Consequently, having noted a large barometrical dodecuple oscillation on March 2, he was certain that by the 8th the regular thermometrical dodecuple oscillation for March should appear very decidedly. The deviation of the thermometrical oscillation is uncertain, to the extent of four or five days.

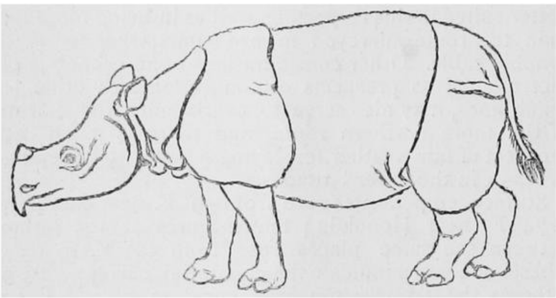
Everything is empirical in this wonderful method of announcing future oscillations of the thermometer by the careful observation of the barometer.

M. Charles Sainte-Claire Deville is of opinion that the phenomenon is owing to the presence of certain cosmical streams of meteoric bodies which may chance to be distributed in an irregular manner in the celestial space. These do not always keep just in the same place, owing to multifarious perturbations; they also vary in breadth, thickness, &c. All these assumptions are merely theoretical, but the existence of the dodecuple period in itself is based on pure observation, and cannot be questioned like the explanation offered for its origin.

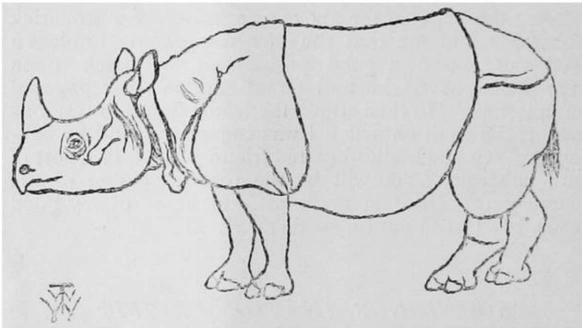
W. DE FONVIELLE

ON THE ARRANGEMENT OF THE SKIN-FOLDS IN THE ONE-HORNED RHINOCERI

IN the two accompanying woodcuts Mr. T. W. Wood has very carefully and accurately mapped out for us the manner in which the peculiar skin-folds, so conspicuous in both the Indian one-horned rhinoceri, are arranged over the surfaces of their bodies. The sketches were both taken from the specimens now living in the Zoological Gardens, the Indian animal (*Rhinoceros unicornis*) being a fully adult male, presented by Mr. A. Grote in 1864, and the Javan (*R. sondaicus*), the not quite full-grown example, of the same sex, just purchased. A fortnight ago (NATURE, vol. ix. p. 363) we mentioned some of the most important points by which the two species



R. sondaicus.



R indicus.

are distinguished, laying stress on what is rendered so much more evident by the sketches we now give, namely, the peculiar manner in which the lateral shoulder-fold—which in the Indian species does not run up the middle line of the back, but is lost over the upper part of the scapula before it reaches the post-scapular transverse fold, as it is continued longitudinally backwards—in *Rhinoceros sondaicus* is carried perpendicularly upwards along the middle of the scapular shield, quite to the back, so as to cut off an extra, independent, saddle-shaped, small, median segment, which covers the nape of the neck. The peculiar notch in the post-scapular transverse fold, and the less extent of the longitudinal fold in the gluteal shield in the Javan species, is also very apparent. Another point which is well indicated is the difference in the shape of the upper lip in the two animals, it being short and blunt in *R. indicus*, whilst it is long, pointed, and semi-prehensile in *R. sondaicus*.

The head of the Javan rhinoceros is also proportionately smaller, whilst the skin-folds along the inferior surface of its neck are more symmetrical and numerous, being arranged so as to appear very like the surface of a coarse three-cord braid. Its skin, especially over the back, is covered with hair to a degree which would hardly have been expected, as in the Indian species there is but little hair to be seen. The ears are also fringed, much in the same way that they are in *Rhinoceros lasiotis* and *R. sumatranus*, the two Asiatic two-horned species.

The two sketches are made of one size to facilitate comparison, but it must be borne in mind that the Javan animal never reaches anything like the bulk of its Indian ally. It is also almost certain that its skin never becomes so coarsely tuberculated.

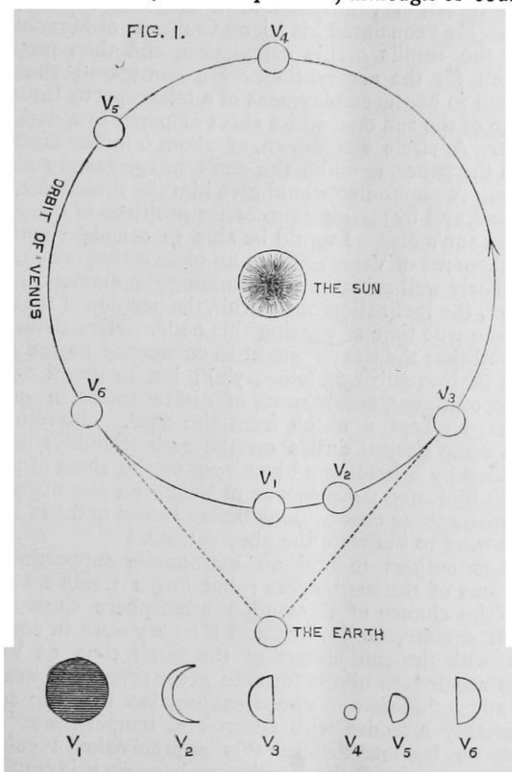
In rhinoceri kept in confinement there is nothing to be learnt from the shape or length of the horns, because that depends so much on the opportunities which their owners have had of rubbing them down. In the wild state the continual employment of the horn or horns in tossing and dividing comparatively yielding substances, such as loose earth and wood, causes them to become pointed, long, and polished, because they wear at the sides almost entirely. But in captivity the seasoned wood, iron, and stone of the cages only break off the tips and leave the sides comparatively unworn, or very unequally so; this is why museum specimens of horns are generally so very unlike those found on exhibited living animals.

Those who noticed the illustrations we gave two months ago (NATURE, vol. ix. p. 227) of the huge *Brontotherium ingens* discovered by Prof. Marsh, will be struck, on looking at the Javan rhinoceros, with the general similarity in the proportions of the head in the two animals. The nose is undoubtedly different, but there is the same extreme shallowness of the frontal and interorbital region, combined with great zygomatic breadth. In Brontotherium the two expanded symmetrical nasal processes were probably covered with tough skin, like those on the face of the wart-hog, to replace in function the coreless but none the less well-developed horn of the rhinoceros.

THE COMING TRANSIT OF VENUS

I.

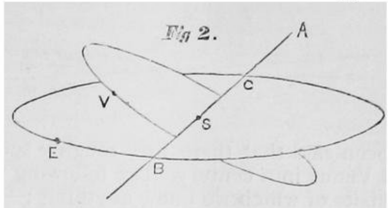
IN days of old it was supposed that the earth held the central position of the solar system, and that moon, sun, and planets moved round it, each in its own orbit. The moon was supposed to be nearest to us, then came Venus, then Mercury, after that the sun, then Mars, Jupiter, and Saturn. We now know that of all these the moon is the only one which revolves round the earth, and that all planets go round the sun in the following order:—Mercury, Venus, the earth, Mars, Jupiter, Saturn. These are all the planets which were known to the ancients. Since Mercury and Venus were formerly supposed to be lower than the sun, and all the others higher, the name of *inferior planets* was given to the former, and *superior planets* to the others. These terms are still retained by astronomers, though the ideas that gave rise to these terms are long since exploded. Fig. 1 shows the phenomena exhibited by an inferior planet in the course of its journey round the sun. V is the planet Venus in the different parts of its orbit. E is the earth, which is shown in the figure always in one position, although of course it



also describes an orbit round the sun. We are naturally led by a study of the diagram to three points of interest concerning the motions of an inferior planet.

The first is that the planet can never seem to be far distant from the sun. Venus moves round the sun in the direction shown by the arrow. The earth rotates in the same direction. We are supposed to be looking down upon the solar system from some point in the northern heavens. It will be noticed that when the planet leaves the point V_1 she will seem to recede from the sun more and more, until she reaches the position V_3. She can never be farther from the sun than this, and is then said to be at her greatest eastern elongation. She then approaches the direction in which the sun is seen, until she is lost in the brightness of his rays. During all this time she is seen best in the early morning before sunrise, setting before the sun. When Venus has passed this position her distance from the sun appears to an observer upon the earth to increase until she reaches V_6, her greatest western elongation, when she again begins to approach the sun.

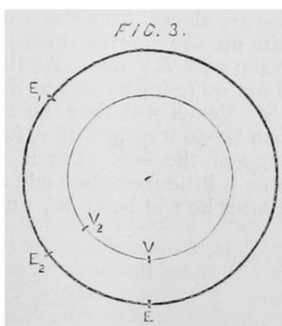
The next point to be noticed is that she is sometimes a great deal closer to the earth than at other times; and when she is most near to the earth she appears to be larger. At her closest approach to the earth she is only about 26,000,000 of miles away; but when farthest off her distance is 158,000,000 of miles. Her apparent size is



therefore much greater in the first case than in the second. These differences are shown at the lower part of Fig. 1.

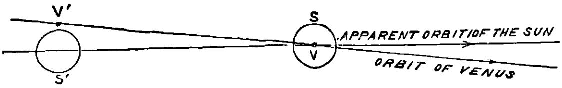
The third point to be mentioned is that she exhibits phases just as the moon does. In any position that hemisphere alone is illuminated which is directed to the sun; so that in the position V_3, when we can only see one-half of that hemisphere, she will have the appearance of a half-moon. So in the position V_2 she has a crescent form, and at V_5 a gibbous form. The apparent size and shape of the planet in its different positions are shown in the lower part of Fig. 1.

The question now arises, what will happen when Venus is between us and the sun? In the first place, since her illuminated hemisphere is turned away from us, she will appear to be black; so that we shall have no chance of seeing her, unless she be seen as a black spot upon the bright surface of the sun. We would naturally expect that this should happen every time that the planet is at its least distance from us. A simple consideration shows that this need not be the case. The orbits of Venus and the earth do not lie in the same plane. In other words, we cannot represent accurately the paths of Venus and the earth by a drawing upon a sheet of paper. The orbit of Venus would have to be tilted up above the plane of the earth's orbit. Both of these planes pass through the sun, but they are inclined to each other at a certain small angle. This will be seen by a glance at Fig. 2, where V represents the orbit of Venus, E that of the earth. The line



AB, which passes through the sun S, is called the line of nodes; and it is quite clear that in order to see Venus as a black spot upon the sun both the earth and Venus must lie approximately on this line of nodes. Now it generally happens that when Venus is at her least distance from the earth, these two planets occupy some such places as V and E, so that she seems to be above the sun; and, not being illuminated, she is invisible. Only twice in a century does she reach the node, so nearly at the same time as the earth, as to be seen as a black spot upon the sun. Such a phenomenon is called a transit of Venus. If it happen that Venus seems to pass across the centre of the sun she takes about eight hours to complete the passage. The earth occupies the position A always in June, and the position B in December. If there be a transit of Venus when the earth is at B, Venus is said to be at the *descending* node, because then she is descending from the northern portion of her orbit to the southern. When Venus is at C she is at her *ascending* node.

FIG. 4

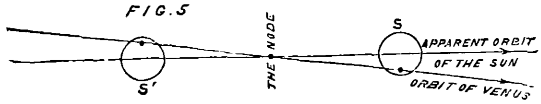


It has been said that there are, roughly speaking, two transits of Venus in a century. The following table shows all the transits of which we know anything :—

1631. Predicted by Kepler, but not observed.
1639. Predicted and observed by Horrox.
1761. Predicted by Halley ; observed by many.
1769. Observed generally.
1874.
1882.

It will be noticed that the transits occur in pairs, eight years apart ; the reason of this can easily be rendered clear. The earth takes 365·256 days to go round the sun ; Venus takes only 224·7 days. Suppose then that at any particular date Venus and the earth are at the node simultaneously, viz. at V and E, Fig. 3, a transit of Venus over the sun's diameter will be seen. When Venus has completed a revolution the earth will have moved away to E_1, and Venus will not overtake the earth until they reach the positions V_2 and E_2. This is 583·920 days from the time when they were at V and E ; but V_2 and E_2 do not lie upon the line of nodes ; hence there can be no transit. After another 584 days Venus will again be in conjunction with the sun, but still not on the line of nodes. But the fifth conjunction occurs after 2919·6 days (5×583·920) ; and the earth completes eight revolutions in 2922·05 days. Thus it appears that, at this conjunction of Venus with the sun, the earth and Venus are very near to their old positions V and E. Hence they are almost on the line of nodes. In this case we can without difficulty examine the possibility of a transit. If we suppose the motion of the earth to be stopped, the apparent motions of the sun and Venus may be represented as in Fig. 4, where a portion of the orbit of Venus and of the ecliptic are shown near the nodes. When the sun and Venus are on the line of nodes simultaneously S represents the sun and V Venus. At the fifth conjunction the sun will not quite have reached S, but will be 2½ days behind at S′ ; Venus will then be at V′. Now in this case there can be no transit visible, for here Venus is quite out of range of the sun. But if in the original transit the sun was a little past the node as at S (Fig. 5), then eight years after he will be at S′, and there will be

FIG. 5



another transit. It follows from this that there will be a pair of transits eight years apart, only when in the first one Venus does not pass close to the sun's centre. This equality of eight revolutions of the earth, with thirteen of Venus, is very interesting, because this fact was shown by the present Astronomer Royal to account for an inequality in the earth's motion due to the attracting influence of Venus. The result of a short calculation informs us that for positions of Venus and the earth near the line of nodes, Venus is at one conjunction 22′ 16″ distant from her position at the conjunction which occurred eight years previously,* this distance being measured at right angles to the ecliptic. Now the sun's diameter is 32′. This shows why, generally, there are two transits eight years apart.

The first prediction of a transit of Venus was made by Kepler,† and was calculated from his Rudolphine tables. In 1631, the year predicted, astronomers of Europe were eagerly on the watch for so rare a spectacle. But the calculation was in error, so that it took place when the sun was below the horizon in Europe, and was consequently invisible.

After this no astronomers seem to have interested themselves about the possibility of such an occurrence, with one exception. Jeremiah Horrox, a curate of the village of Hoole, near Liverpool, was much devoted to astronomical pursuits.‡ He possessed some tables for calculating the places of the planets ; but his observations did not agree at all with them. He had, however, before discovering the faults of Lansberg's tables, calculated from them the future positions of the planets. This work, with corrections deduced from his own observations, led him to predict a transit of Venus, visible in England, for the year 1639. He acquainted his friend Crabtree, of Manchester, with the results of his calculation, and then prepared himself for the observation. He considered the best method to be the employment of a telescope to throw an image of the sun on a white sheet of paper in a darkened room. A circle was drawn, of about 6 inches diameter, upon the paper, to make the sun's image exactly fill the circle. A plumb-line would give him the direction of the vertical, and by marking successive positions of the planet on the sun's disc, he would be able to calculate many of the elements of Venus. Such an observation is of course peculiarly well suited for determining the diameter of the planet, the inclination of its orbit, the position of the node, and the true time of passing this node. His calculations showed that the transit ought to commence on the afternoon of November 24 (old style) ; but to guard against disappointment, and because of discrepancies in various tables, he kept a watch from the 23rd. On returning from some clerical duties on the 24th (Sunday) he was gratified by beholding a black spot on the sheet of paper, which indicated the presence of Venus on the sun's disc. He made three observations before sunset and has left us a drawing to illustrate the observations. §

It is curious to find an astronomer supporting the opinions of the astrologers ; but in his treatise we find that the chance of a clouded atmosphere caused him much anxiety, for Jupiter and Mercury were in conjunction with the sun almost at the same time as Venus. This seemed to him to forbode great severity of weather. He adds, " Mercury, whose conjunction with the sun is invariably attended with storm and tempest, was especially to be feared. In this apprehension I coincide with the opinion of the astrologers, because it is confirmed by experience ; but in other respects I cannot help despising their more than puerile vanities." But we must not laugh at Horrox for his opinion. In our own day there is a considerable number of diligent astronomers who believe that the cyclones in the Indian Ocean, certain other winds, the growth of vines, and various other

* For at the fifth conjunction the earth is 2·45 days distant from her place at the original conjunction. This is equivalent to 2° 24′ 59″, when viewed from the sun, from which subtract 2′ 44″ (= the retrogression of the node of Venus in eight years), and we have 2° 22′ 15″ = the angular distance of the earth from its corrected original position, as seen from the sun. The ratio of this to the angular distance of Venus from her original position as seen from the earth $= \frac{\text{dist. of Venus from earth}}{\text{dist. of earth from sun}} = \frac{277}{723}$. Multiplying 2° 22′ 15″ by 723, and dividing by 277, we have 6° 11′ 17″. Multiplying this by ·06 = tan 3° 23′ 31″, which is the inclination of the orbit of Venus, we have 22′ 16″ = the latitude of Venus at the fifth conjunction.

† "Admonitiuncula ad Curiosos rerum Cœlestium," Leipsic, 1626.

‡ See NATURE, vol. viii. p. 113.

§ Venus in Sole Visa.

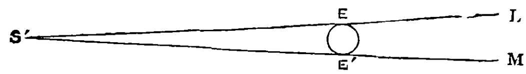
phenomena, are in part regulated by the positions of Venus and Jupiter with respect to the sun.*

Mr. Horrox's observations have been of great value in perfecting the tables of Venus. He was further led by a kind of analogy, much in vogue at the time, to deduce from his observations a value of the sun's distance from the earth. It will readily be understood that if we could find out what size, in angular measure, the earth would seem to have if viewed from the sun, we should have a means of determining how much greater the distance from the earth to the sun is than the diameter of the earth. For, suppose S (Fig. 6) to be the position of an observer placed upon the sun, S L, S M the directions in which he must look to see the opposite sides of the earth, so that the inclination of these lines is known. All we have to do now is to draw a circle of any size and move it about between the lines S L, S M, until it just fills the interval, as at E E′. If now we measure with a ruler how much greater S E is than E E′ we shall know the distance from the earth to the sun, the earth's diameter being taken as the unit of measurement; and if we multiply this by the diameter of the earth measured in miles we shall know the distance from the earth to the sun, in miles. All that we require to know is the size of the angle E S E′. Horrox estimated the probable value of this angle in the following manner. From the observations of Tycho Brahé it appeared that during the transit of Venus the apparent diameter of the planet would be 12′ 18″; while Lansberg found 12′ 21″; and Kepler 6′ 51″. Horrox found from his measurements that it was only 1′ 16″. The error of ordinary observations arises from the apparent enlargement of the planet's disc through irradiation. Gassendi had in the same manner, during the transit of Mercury in 1631, reduced the apparent diameter of Mercury to scarcely 20″. From these data it can be found that the apparent diameters of Venus and Mercury as seen from the sun would be 21″ and 34″ respectively. Proceeding to the other planets he arrived at the general conclusion that each of them would, if viewed from the sun, have an apparent diameter of about 28″. Applying this to the case of the earth, he showed that the distance of the earth from the sun must be 7,500 diameters of the earth (it may be well here to state that the latest measurements show the apparent diameter of the earth as viewed from the sun to be about 18″, and the distance = 11,400 diameters). This analogy by Horrox gave a much closer approach to the truth than any previous conjectures.

Before taking leave of Horrox, we must say a few words to his memory. He died at the early age of 23. During his short career he showed a remarkable aptitude for the acquisition of knowledge, and for the striking out of new ideas. He lived at a time when the scientific spirit of the age was leading up to the theory of gravitation, and many passages in his writings show that he had even then grasped the grand idea of the theory, and that he was well fitted to become its constructor and its expounder. His researches on the lunar and planetary theories indicate the magnitude of his talents.

We have already mentioned some of the uses to which careful observations of a transit of Venus may be applied; viz. the correction of the elements of the planet's orbit. But the observation also leads us to a knowledge of the distance of the sun from the earth, and in a manner much more direct and logical than that employed by Horrox. There is an opinion very prevalent that a transit of Venus affords the best means of determining this distance. So

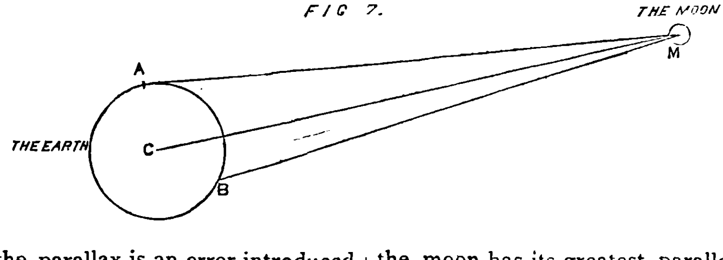
FIG. 6



far as our present knowledge goes we are hardly justified in such a statement until after the observations that shall be made in the present year.

Before entering upon the method by which we measure the sun's distance, let us devote a few lines to explaining what is meant by the word *parallax*, which is continually employed in such discussions. Let a man stand in a street exactly north of a lamp-post. The lamp-post will seem to be south of him. Now let him cross over to the other side of the street. The lamp-post will now be in some other direction, such as south-west. This movement of the direction of the lamp-post is the effect of parallax. Now let us suppose, by a stretch of imagination, that a man observes the moon from the centre of the earth. He will see it in the direction C M (Fig. 7). If now he goes to A he will see it in the direction A M. The angle AMC through which the moon appears to have been moved is the parallax of the moon as observed from A.

FIG. 7.



It will be noticed that the parallax is an error introduced into the observed position of the moon, and which must be allowed for if we wish to get the position as seen from C. Moreover, the parallax at B is different from what it is at A. But at no point on the surface of the earth can the parallax be greater than at A. And if we know the parallax of the moon at A, we can deduce that at B from a knowledge of the relative positions of A, B, and C. Hence it is useful to have a distinct name for the parallax at A. Now it will be noticed that a line drawn from C to A is the vertical line at A; hence the moon M will appear to be on the horizon to an observer at A; and hence the moon has its greatest parallax when on the horizon. For this reason the parallax at A is called the moon's *horizontal parallax*. Further, since the equatorial diameter of the earth is greater than the polar, the parallax will be greater, when the moon is on the horizon, to an observer at the equator than to an observer at one of the poles. Hence the greatest parallax we can have occurs when the moon is on the horizon and the observer is at the equator; this value of the parallax is the *equatorial horizontal parallax*. In the same way the sun has an equatorial horizontal parallax, and if we knew its value we could find out the sun's distance from the earth as explained above (Fig. 6).

GEORGE FORBES

(*To be continued.*)

* See the researches of Messrs. De la Rue, Stewart, and Loewy on the connection of sun-spot frequency with planetary positions, "Phil. Trans."; also the writings of Mr. Meldrum, Mr. E. J. Stone, Prof. Balfour Stewart, M. Poey, and others, on the connection between terrestrial phenomena and sun-spot frequency.

THE "CHALLENGER" EXPEDITION

III.

St. Vincent, Cape de Verde Islands

ST. VINCENT, one of the Cape de Verde Islands, noted in the old gazeteers for its wood, water, wild goats, turtles, and saltpetre, was visited by the *Challenger* in July and August last. From a record of this visit we gather the following particulars about the island itself and of the plants growing there. The island is small, not more than twelve miles by six, comparatively flat in the centre, but surrounded by higher land. This range of high land is divided by a series of deep valleys, forming ridges which are again divided into transverse valleys. Most of the hills are from 700 to 1,200 ft. high, but one in the south is over 2,200 ft. high. St. Vincent is sometimes visited by long periods of drought, extending occasionally to a year's duration, during which time the whole island has a parched, sterile appearance. The most abundant plant in the island is *Lavandula rotundifolia* Bth., which forms small thick bushes; there is also on the summits of the higher hills *Euphorbia tuckeyana*, Steud., and on the sandy plains as seen from the vessel in Porto Grande, reaching inland from the shore, were dense masses of bushes of *Tamarix gallica*. In one spot, springing up from amongst these bushes, was the well-known tamarind tree (*Tamarindus indica* L.), so valuable both in the East and West Indies, for the sake of the agreeable acid pulp contained in the pod, which when preserved in sugar forms "Tamarinds" of commerce. Side by side with the tamarind grew *Acacia albida* Del., and *Terminalia catappa* L., the first being one of the many spiny acacias found on the African continent, where it forms a large straggling branching tree, with straight, stout spines, sometimes ¾ in. long. The *Terminalia* is a native of India, but has been found in Upper Guinea, though probably not indigenous. The seeds are almond-shaped, white, and of an agreeable taste. In the plains *Tribulus cistoides* L., a spreading prostrate or decumbent plant, occurs in great abundance, as also a small grass. Nearly all the vegetation, however, had a shrivelled, dried-up appearance, with the exception of the lavender, upon which a few fresh green leaves were to be seen. The effect of rain in changing the aspect of vegetation on this island is said to be almost instantaneous, not only in bringing out the young foliage of perennial plants, but also in causing a thick carpet of seedlings to spring up. Though the hill slopes and the lower parts of the valleys are in some parts of the island covered with a thick grass, the drought causes it to become so dry that goats and cattle frequently die from sheer starvation.

On the Green Mountain, at an altitude of about 200 ft. above the level of the sea, the gardens contained pumpkins, sugar-cane, a small kind of date-palm, and maize; cotton bushes also grew in the neighbourhood. At another 500 ft. there were Euphorbias and the woody Composites. At 1,000 ft. there were *Echium stenosiphon* Webb, in flower; and at 1,300 ft. occurred patches of moss and marchantia, while at 1,700 ft. *Statice jovi-barba* Webb was abundant. The *Lavandula rotundifolia*, which is found at the very top of the mountain, has here a very different aspect from that before described, inasmuch as it is green and vigorous-looking. In the south-west of the island, at a height of 900 ft., was discovered a single plant of *Sarcostemma daltoni* Dene, which grows on the cliffs at St. Jago, almost down to the sea. On the top of the Green Mountain the land is much cultivated with potatoes, tomatoes, pumpkins, maize, and similar plants. The position is so favourable to the growth of the tomato that it appears to have run wild. The origin of many of the introduced weeds which grow on the mountain is no doubt traceable to the imported seeds of the vegetables just mentioned.

At an elevation of about 2,000 ft. was a group of agaves planted in the form of a double circle; many of them had flowering spikes about 10 ft. high. The marked differences of aspect caused respectively by the trade-winds and the sun, at altitudes suitable for plant growth, are points of much interest, illustrations of which may be had in the fact that *Aizoon canariense* L., which grows on the windward and shady side of Bird Rock, nearly down to the sea-level, does not commence till 700 feet or 800 feet on the leeward sides of the main island; the Euphorbias and woody Composites are found at about the same elevation, while on the other side they reach nearly down to the sea. On the windward slopes of the mountains, on the southern side of the island, the vegetation commences at a higher elevation, being kept back by the wind becoming heated and dry from its passage across the hot central plain.

Sinapidendron vogelii Webb, a cruciferous undershrub, with yellow flowers, grows on the cliffs on the weather side of the island; and *Samolus valerandi* L., known to us as the brookweed or water pimpernel, an erect plant, from 8 in. to 10 in. high, growing in marshy places or near springs, was also seen, but only in a single isolated patch near a small stream. This plant is remarkable for its very wide geographical range, being found in almost every country where the soil is wet and gravelly, and though seen only in this one spot in St. Vincent, it grows abundantly in St. Jago by the stream in St. Domingo Valley.

As seen from the sea, the rocks of St. Vincent present a singular appearance, owing to the presence of a thick incrustation at water-mark of masses of calcareous algæ, which either follow the forms of the rocks, or occur in rounded masses, their delicate tints of white, light pink, or cream colour, considerably heightening the effect. These incrustations are frequently bored by *Lithodomus candigerus* and other molluscs, and small sponges and Bryozoa occupy the cavities between them and the rocks.

St. Paul's Rocks

The isolated rocks known as St. Paul's Rocks lie to the north of the equator about 1°, and in longitude 29° 15′ W., nearly midway between the South American and African coasts. They are in truth mere rocks, not more than a quarter of a mile long, and rising to a height of from 50 to 60 ft. above the sea. They are described by travellers as being quite bare of land-vegetation even to the exclusion of lichens, the only vegetation in fact being numerous species of algæ.

From an examination made of the rocks during the two days' stay of the *Challenger*, it seems that the species of algæ are by no means numerous, fourteen species being all that were found; so powerful indeed is the wash of the waves that it seems to be too much even for these marine plants to retain their positions. The water also deepens very rapidly round the rocks, so that it is not likely many species would be found there.

A similar incrustation of calcareous algæ is seen upon the rocks as at St. Vincent. It here forms a deep pinkish white band at tide mark, and is riddled through and through by a small annelid. In some places the colour of the incrustation is white, and above this is a dark red-coloured algæ, covering the rocks for several feet. At the bottom of the small bay formed by the circlet of rocks and extending out in the sea to a depth of twenty fathoms, is a thick growth of a green-coloured sea-weed (*Caulerpa clavifera* Ag.), together with another species of smaller growth. The former is loosened from the bottom by the action of the waves, and is gathered up by the noddies (*Sterna stolida*) to build their nests.

A few diatoms and oscillatoriæ occur in stagnant pools, among them being *Navicula didyma*, *Rhabdonema adriaticum* and *Biddulphia pulchella*. A careful examination of the guano found in the hollows of the rocks showed that no diatoms were present, but fossil fragments of incrustation formed of a kind of nullipore, combined with pebbles and broken shells, occur in the singular veins of conglomerate traversing the rock.

NOTES

WE are glad to hear that Government have consented, though tardily, to give effect to the wishes of the country, by offering to defray the expenses of the funeral of Dr. Livingstone in Westminster Abbey. The *Times* states that a merchant in the city of London, in view of the inability of Dr. Livingstone's family to bear the expense of the ceremonial, had already volunteered to be at the charges of this melancholy tribute of respect, but it obviously would have been unbecoming the dignity of the nation which has been honoured by the achievements of the illustrious traveller for the last honours to have been rendered him at the cost of any private person. The Southampton Town Council has resolved to receive, with fitting honours, the remains of Dr. Livingstone, which are expected to arrive at that port very shortly.

AT an influential meeting held at Edinburgh on Monday, it was resolved to extend on a large scale the University buildings and to remodel those already existing, so as to suit them to modern requirements. We are glad to notice that the importance of Science in University teaching was insisted on at the meeting, and we hope that in the extended and remodelled University scientific teaching and research will be accorded a prominent place. Of the 100,000*l*. required, 55,000*l*. have been already subscribed At Dundee, on the same evening, Dr. Lyon Playfair, speaking on the same subject, urged the importance of placing the Edinburgh University in a position in which it would be able to teach, in a thoroughly practical manner, the sciences and the professions resting upon them. He dwelt on the great importance of scientific education, and said that any nation which bestowed more science and skill on any one of their manufactures than we did must inevitably beat us in the race. He pointed to the advantages which Germany had derived from bestowing special attention to scientific instruction, and said that in Manchester we now saw the remarkable spectacle of an inland trading town of England in which Germany occupied much of the field of industry.

THE French Government have only done an act of justice in conferring a pension of 12,000 francs upon M. Pasteur in consideration of his services to science and industry.

COLONEL STUART WORTLEY has been appointed by the Commissioners of Patents to the Curatorship of the Patent Museum at South Kensington, vacant by the death of Sir Francis Pettit Smith.

SIGNOR AUGUSTO RIGHI has been appointed Professor of Natural Philosophy in the Instituto Technica Reale of Bologna.

THE Council of the Society of Arts has decided to offer a prize, consisting of a gold medal or 20 guineas, for the best essay "On the Cultivation and Manufacture of Indian Teas."

A MEETING of the local general committee of the British Association was held in the rooms of the Chamber of Commerce Bradford Exchange, on March 31, to receive a report as to the reception fund. It appeared that the total receipts were 3,248*l*. 16*s*. 8*d*., and the expenditure 3,097*l*. 7*s*. 2*d*., leaving a balance of 155*l*. 9*s*. 6*d*. in the bank, subject to the expenses connected with the winding up of the committee's duties. It was agreed that the balance remain in the hands of the local executive committee until all expenses are paid, and that the amount which may remain be given to the Bradford Philosophical Society, an institution having an object kindred to tha of the British Association.

M. LEVERRIER has been appointed president of the section of Science at the meeting of the Delegates of Learned Societies, which will be held at Sorbonne.

FROM the sixth quarterly report on the Sub-Wealden Exploration we learn that during the last two months a depth of 359 ft. has been bored, making a total of 671 ft. The borings are still in the Kimmeridge clay. In this deposit indications of petroleum have been noticed, and at depths of from 600 ft. to 650 ft. it was particularly observable. Occasional veins of carbonate of lime have been met with crossing the cores obliquely, but the report states that all the beds yet passed through are horizontal. One of the most important results of the exploration has been the discovery of gypsum and other beds which are likely to prove commercially productive. Attached to the report is a list of the fossils which have been found. The committee report that they have sufficient funds to continue the work to a depth of 1,000 ft., and should it be deemed desirable to go beyond that depth, a conference will be held to consider the question before soliciting further contributions. The present balance in hand is 576*l*. 4*s*. 4*d*.

IT is said MM. Croce Spinelli and Sivel will be awarded a prize for their last aeronautical ascent, in which they took with them oxygenised air.

ANOTHER aeronautical ascent took place on Thursday week from Lavillette gasworks in a new balloon called "Michel le Brave," which is to be sent to Roumania. The measurement is 1,500 cubic metres. It was sent up with six persons and descended at Vic-sur-Aisne in a regular storm; large trees were uprooted, but no bodily harm was received by the balloonists. It is intended to have several other ascents next spring.

THE greatest alarm has been caused in North Carolina and Tennessee by the appearance of what seems to be volcanic phenomena in the former of these states. The scene of the reported disturbance is Bald Mountain, in the south-western part of M'Dowell County. Rumblings were heard during several days, apparently coming from the interior of the mountain, and one letter, dated March 20, states that near the summit of the peak an area of nearly an acre was agitated by subterranean upheavals, and from which smoke and vapour issued. The people of the surrounding district are reported as being in the greatest consternation, ceasing from work and living in common, and evidently quite expecting that the final catastrophe is impending.

SEISMIC commotions of some magnitude have been felt in Algeria, at Algiers, and surrounding places. The centre of commotion seems to have been somewhere in the vicinity of Cherchel, where the barracks have suffered much. The first shock was felt on March 28 at 11.10 A.M.

AN Alpine club has been established in Paris under the presidency of M. de Billy. The rules will be similar to those of English, Swiss, Italian, and Austrian Alpine clubs. It is intended to issue a periodical containing the papers read before the Association. More than 100 members have been enrolled.

THE sittings of the Bureau des Longitudes are now being held at the Collége de France.

THE Mexican Axolotls, which have for some time been exhibited in one of the handsome vases in the entrance-hall of the Brighton Aquarium, spawned about a month ago. As the parents showed some disposition to devour their eggs, the latter were removed to one of the troughs of the salmon-hatching apparatus, where the young axolotls may now be seen, having just been hatched after a period of 29 days in the egg.

A SUPPLEMENTARY credit of 4,000*l.* has been voted by the Versailles National Assembly for paying a part of the expenses incurred by the observation of the Transit of Venus. Six members belonging to the ultra-clerical party have given a negative vote on a division. It is said they are not believers in the Copernican theory, and have no faith in the astronomical observations.

THE Rev. Henry Moule, after a series of experiments extending over twenty years, has devised a process of manufacturing an illuminating gas from Kimmeridge clay.

THE educational means of Harvard University have recently been increased by the addition of an institution which will make that University one of the most complete in the United States. This Institution is known as the "Bussey Institution," after Mr. Benjamin Bussey of Roxbury, Mass., who about thirty years ago left to the University a magnificent sum of money and a small estate for the purpose of promoting the scientific study of agriculture and horticulture. The money was allowed to accumulate for many years, and has since been increased by 100,000 dollars left by Mr. James Arnold, Merchant, of New Bedford. The estate has been to some extent laid out for the purpose intended, and several suitable buildings, including a laboratory, have been erected, and the Harvard authorities have devised a course of instruction and investigation on a broad and thoroughly scientific basis. The appointments already made include:—An instructor in Farming, a professor of Agricultural Chemistry, a professor of Horticulture, a professor of Applied Zoology, an instructor in Entomology, a director of the Arnold Arboretum, and a librarian and curator of Collections. The institution is intended both for instruction and investigation, though we are glad to see that students' fees are not necessary to the support of the institution. The permanent funds provided by Mr. Bussey will enable the President and Fellows to maintain the Institution as a scientific station, like the Astronomical Observatory or the Museum of Comparative Zoology at Harvard College, until the time shall come when there shall be a demand for its privileges as a school. The experiments and investigations made at the Bussey Institution will be published from time to time in a Bulletin, the first number of which is before us. It contains four papers by F. H. Storer, professor of Agricultural Chemistry in Harvard University, one containing analyses of some commercial fertilisers, another of American "shorts" and "middlings," a third On the Agricultural Value of the Ashes of Anthracite, and a fourth containing a Record of Trials of various Fertilisers on the ground of the Bussey Institution. The only other paper is a useful one by Dr. Slade, professor of Applied Zoology, On the Humane Destruction of Animals.

THE French Society of Geography, we learn from *La Nature*, has just received news of a French expedition which has been exploring Terra del Fuego. On December 7, last year, the expedition landed on the coast of that island, and proceeded into the interior. The explorers found a large lake of 25 kilomètres in circumference, surrounded by luxuriant vegetation, and literally covered by an army of wild fowl, among which the most abundant were ducks and geese. These regions are inhabited by rude but hospitable tribes; the women especially are very affable and obliging. One of them, in exchange for some pieces of sugar and common handkerchiefs, gave the leader of the expedition an object to which she attached an immense value, and which she preserved as a relic,—the lid of a sardine box.

WITH a view of properly exhibiting the geological and metallurgical resources of America at the forthcoming exposition at Philadelphia, an association has been organised, embracing such names as those of Prof. Leslie, Prof. Genth, Prof. Raymond, Prof. Wyman, Prof. T. Sterry Hunt, George H. Cook, and others, to whom is to be intrusted by the Board of Centennial Commissioners the duty of collecting whatever will best answer the purpose in question.

THE Paris Jardin d'Acclimatation has succeeded in "breaking-in" some zebras so far as to induce them quietly to draw a carriage, and one permits children to ride round the gardens on its back.

DR. HAYDEN, the head of the Geological and Geographical Survey of the U.S. Territories, has commenced the publication of a bulletin to communicate such announcements of new facts made by any member of his party as it is desirable to bring promptly to the notice of the scientific community in advance of their publication in his reports. The first number of this Bulletin, bearing date January 21, is occupied by a list of the members and collaborators of the survey for 1873, and a list of the publications, from which we learn that six volumes of the reports have appeared from 1867 to 1873, and that seven volumes of miscellaneous publications will be published in octavo form, the most elaborate being the hand-book of the Ornithology of the North-western Territories, by Dr. Coues. Several quarto volumes will also be sent out, of which there have been actually published one by Prof. Leidy, on the extinct vertebrata of the Western formations, and one on the Acrididæ of North America, by Prof. Cyrus Thomas. This quarto series, it is expected, will include ten volumes, among them memoirs on the vertebrata of the cretaceous and Tertiary formations, by Prof. Cope; one each, on the fossil plants, by Prof. Newberry and Prof. Lesquereux; on the fossil invertebrates, by Prof. Meek; and the volume on general geology, by Prof. Hayden. Thirteen maps have been published for the survey, those of the Yellowstone region being especially valuable. The body of the bulletin is occupied by a report on the stratigraphy and Pliocene vertebrate palæontology of Northern Colorado, by Prof. Cope, in which he presents the parallelism of the formations recently investigated by him with those earlier known and in other parts of the West. He concludes that, although these formations have generally been considered as Tertiary, the geological evidence shows them to be strictly mesozoic, as in the great lignite formations on the Missouri River. During the past season twenty-one new species of vertebrates were obtained in the Pliocene sandstone at the head of the watershed between the South Platte River and the Lodge-pole Creek.

THE *Belgique Horticole*, for February, publishes a complete list of botanical gardens throughout the world, with the names of their curators and of the professors of botany at the different towns.

THE Science and Art Department has issued a catalogue of apparatus for instruction in geology, mineralogy, animal physiology, elementary botany, general biology, principles of mining, and physical geography.

THE *Brisbane Courier* of December 30, 1873, publishes the following official telegram from Mr. Walter Hill, the Government botanist, dated from Cardwell on the 27th and received by the Queensland Secretary for Lands:—"Since November 20 we have examined the banks of the Mulgrave, Russell, Mossman, Daintree, and Hull Rivers, and have been more or less successful in finding suitable land for sugar and other tropical and semi-tropical productions. The ascent of the summit of Bellenden Kerr was successfully made by Johnstone, Hill, and eight troopers. At 2,500 ft. in height we observed an undescribed tree with crimson flowers, which excels the *Poinciana regia*, *Colvillia racemosa*, *Lagersstroma regia*, and the *Jacaranda mimosifolia*. At 4,400 ft. a tree-fern, which will excel in grandeur all others of the Alboreous class. A palm-tree at the same height which will rival any of the British-Indian species in gracefulness. On the banks of the Daintree we saw a palm-tree cocoa, which far exceeds the unique specimens in the garden of the same genera from Brazil in grandeur and gracefulness. While cutting a given line on the banks of the river Johnstone for the purpose of examining the land, an enormous fig-tree stood in the way, far exceeding in stoutness and grandeur the renowned forest giants of California and Victoria. Three feet from the ground it measured 150 ft. in circum erence; at 55 ft., where it sent forth giant branches, the stem was nearly 80 ft. in circumference. The River Johnstone, within a limited distance of the coast, offers the first and best inducements to sugar cultivation."

WE are glad to observe signs of life in Dundee, says the *Scottish Naturalist*. That town, long noted for its commercial enterprise, has had nearly an equal, but not enviable, celebrity for its poverty and deadness in regard to the study of natural science. But now we trust that that reproach will soon be wiped away, and that the members of the recently founded Dundee Naturalists' Society, a copy of whose constitution is before us, will do good work, and show their fellow-citizens that there are other and more valuable *dona Dei* in the fields, woods, and mountains of the interesting county of Forfar, than that wealth for which the inhabitants of the town of the *donum Dei* are deservedly remarkable. The Society has already upwards of forty members, which number will probably soon be considerably increased. We recommend to the Society the formation of a good local museum of the natural productions of Forfarshire.

IN the forty-first volume of the *Journal of the Asiatic Society of Bengal*, Mr. G. E. Dobson has drawn attention to a particularly interesting feature in the osteology of the Rhinolophine Bats. In the genera *Phyllorhina*, *Triænops* and *Cœlops*, he finds that in the innominate bone the ilium sends forward a process from its upper part, which meets and anchyloses with an extension of the ileo-pectineal spine to form a second foramen above that around which the obturator muscles arise. This peculiarity has not been observed in any other mammal.

THE additions to the Zoological Society's Gardens during the last week include a St. John's Monkey (*Macacus sancti-johannis*) from China, and a Java Chevrotain (*Tragulus javanicus*) presented by Captain Nutsford; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. Webster; three Passenger Pigeons (*Ectopistes migratorius*) from North America, purchased; an Egyptian Monitor (*Monitor niloticus*) six feet long; and a Tuberculated Lizard (*Iguana tuberculata*) from the West Indies, deposited.

SCIENTIFIC SERIALS

American Journal of Science and Arts, March.—This number commences with an interesting paper, by Prof. Leconte, On the Great Lava Flood of the West, and on the Structure and Age of the Cascade Mountains. The flood, commencing in Middle California in separate streams, became in Northern Oregon and Washington absolutely universal; the whole country, mountain and valley, being buried several thousand feet. Its extent cannot be less than 200,000 to 300,000 square miles; its average thickness is probably 2,000 ft., and extreme thickness 3,700 ft. From the structure of the Cascade Range (which extended throughout the entire region of the flood) and palæontological evidence, the author thinks the flood began to occur during or after the Miocene; and the process of flooding probably continued, by successive fissure-flows of lava, chiefly in the Cascade and Blue Mountain Ranges, until the Post-Tertiary; the liquid matter having been squeezed out by horizontal and vertical pressure, while water, percolating through the hot mass, generated volcanoes that continued the up-building process.—Dr. Blake of San Francisco has a paper On the Connection between Isomorphism, Molecular Weight, and Physiological Action. One of the conclusions arrived at is, that among compounds of the more purely metallic elements, the quantity of substances in the same isomorphous group required to produce analogous changes in living matter, is less as the atomic weight of the electro-positive element increases.—Mr. Carey Lea describes some experiments made to determine whether it is a general law that when a metallic compound reducible by light is placed in contact with an oxidisable body (or one capable of uniting with Cl, Br, or I, as the case may be), the capacity of reduction of the compound by any particular part of the spectrum is influenced by the *colour* of the body placed in contact with it. But he did not succeed in thus generalising Vogel's results; which, however, he does not regard as contradicted or disproved.—Some experiments by Prof. Wright on the oxidation of alcohol and ether by ozone, seem to indicate that the vinegar process might be materially accelerated by passing ozonised air through the apparatus.—Prof. Marsh communicates a notice (bearing on the genealogy of the modern horse) of new equine mammals from the Tertiary formation; and we further note papers On Recent Dredging Operations in the Gulf of St. Lawrence (Mr. Whiteaves); On Fossils figured in the Illinois State Geological Report (Mr. Meek); On Dissociation of certain Compounds at very low Temperatures (Mr. Leeds), &c.

Der Naturforscher, February.—We may first note, in this number, an account of some valuable researches by MM. Pettenkofer and Voit, as to the significance of the carbohydrates in nutrition. The authors conclude that carbohydrates, in the animal system, always pass entirely into carbonic acid and water, and do not produce fat; but they save (*ersparen*) the fat produced from albumen, and this in proportion to the quantities of the albumen-fat and the carbohydrate. There is also, in the biological department, a succinct statement of Prof. Haeckel's "Gastraea" theory.—In geology, some observations by M. G. Laube appear to indicate that the transport of *débris* and stones by ice in East and West Greenland is by no means a common thing; and a note by M. Albert Heim describes and explains the formation of certain huge cauldron-like cavities in solid rock in the Gletschergarten at Lucerne.—From an examination of plant-remains found in amber, Prof. Caspary has inferred that Prussia, in the Amber period, must have been much warmer than now; certain Arctic Ericaceæ, supposed to be of the period, probably flourished on lofty mountains.—M. Merget's recent observations on thermo-diffusion of gas in leaves, and those of M. Reinke on the function of leaf-teeth, are also given; while MM. Fliche and Grandeau study the relation between chemical composition of the ground and vegetation of *Pinus pinaster*. This plant, while a flint-loving species, yet absorbs a considerable quantity of lime; and in soils with much lime, the increased absorption of this salt is accompanied with a decrease in the other ash constituents, especially potash (this being probably the cause of the bad condition of the tree in such soil).—In the department of physics, we have several notes from English sources: On the Elements present in the Sun (Lockyer); On the Affinities of the Magnetic Metals, and On Molecular Phenomena in Glowing Iron (Barrett); On Propagation of Sound in Fog (Reynolds), &c. And in chemistry, there is a note by M. Thomsen, treating of the influence of temperature on chemical phenomena of heat; also a popular summary of M. Ebermayer's researches as to the presence of ozone in the air.—Astronomy is represented by papers on the star shower of November last, and on the direction of the large axes of cometary orbits.

Bulletin de l'Academie Royale de Belgique. No 1, 1874.—In this number M. de Wilde makes some contributions to the theory of bleaching of vegetable fibres which contain incrusting and other matters. He considers that there is substitution of chlorine for hydrogen in the alkaline liquid, which has served to dissolve the incrusting matter, and that chlorine acts, besides, in decomposition of the water, formation of hydrochloric acid, and fixation of oxygen in the organic matter.—The same author communicates notes on the preparation of acetylene, the action of hydrogen on acetylene and ethylene under the influence of platinum black, and the action of the electric effluvia on some gases and gas-mixtures. In the last he confirms MM. Thenard's observations; and acetylene, he finds, is condensed by the effluvia into a liquid which solidifies rapidly, becoming yellow; the solid detonates under the action of heat. Sulphurous anhydride and oxygen combine directly to form sulphuric anhydride.—Continuing his researches on glyceric derivatives, M. Henry describes an octobromide obtained by action of bromine on tetrabromide of dipropargyle; and a paper by M. Spring, describing new syntheses of hyposulphurous acid and of trithionic acid, is of theoretical importance as showing the relations between the sulphates and hyposulphates, and between the latter and trithionates.—

M. Gosselet furnishes a detailed account of the southern band of Devonian limestones in the district Entre-Sambre-et-Meuse; and M. Selys de Longchamps makes some additions to a synopsis of the Cordulina.—A programme of five questions for medal competition is announced, the subjects being briefly these: disturbing causes in determination of the electromotive force and inferior resistance of a battery element; relations of heat to the phenomena (especially periodic) of vegetation; embryonal development of Tunicata; composition and mutual relations of albuminoid substances; coal system of the Liège valley.

Archives des Sciences Physiques et Naturelles, Feb. 15, 1874.—In this number M. Dufour gives a detailed account of his researches on the variation of temperature which accompanies diffusion of gases through a porous partition. After describing the apparatus (in which a porous vessel, with thermometer and other tubes inserted in its gutta-percha stopper, was enclosed in a cylindrical glass vessel, and this, enveloped in loose cotton, in a larger earthen vessel), the author studies first the influence of the dry or humid state of gases coming into contact with the porous wall, without diffusion; next, variation of temperature where there is no change of pressure; and third, variation where there is such change. With constant pressure, there is fall of temperature on the side where the denser gas is; and rise on the other side. Each current seems to have a heating effect where it enters the porous wall and a cooling one where it issues. With change of pressure, where this rises within the vessel, through endosmose of a lighter gas, the temperature slightly increases, sinking again as the pressure tends to equilibrium. Where exosmose of a lighter gas causes diminution of pressure in the vessel, the reverse occurs.—From observations of the partial solar eclipse of May 26 last, at three Italian stations, D'Aoste, Moncalieri, and Florence, Prof. Denza finds no sensible influence on the declination needle, either as regards its regular diurnal movement, or the absolute value of its displacement. He is confirmed in the conclusion, previously formed (on data of former eclipses), that no connection has hitherto been demonstrated between the two orders of cosmic facts, eclipses and phenomena of terrestrial magnetism.—M. Charles Lory communicates a note on some facts of structure in the central chains of the Alps.—The *Bulletin Scientifique* gives, as usual, a valuable series of notes on recent progress in Physics, Geology, Zoology, and other branches.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 26.—On the Motions of some of the Nebulæ towards or from the Earth, by William Huggins, D.C.L., LL.D., F.R.S.

The observations on the motions of some of the stars towards and from the earth, which I had the honour to present to the Royal Society in 1872, appeared to show, from the position in the heavens of the approaching and receding stars, as well as from the relative velocities of their approach and recession, that the sun's motion in space could not be regarded as the sole cause of these motions. "There can be little doubt but that in the observed stellar movements we have to do with two other independent motions—namely, a movement common to certain groups of stars and also a motion peculiar to each star." *

It then presented itself to me as a matter of some importance to endeavour to extend this inquiry to the nebulæ, as it seemed possible that some light might be thrown on the cosmical relations of the gaseous nebulæ to the stars and to our stellar system by observations of their motions of recession and approach.

Since the date of the paper to which I have referred, I have availed myself of the nights sufficiently fine (unusually few even for our unfavourable climate) to make observations on this point. The inquiry was found to be one of great difficulty, from the faintness of the objects and the very minute alteration in position in the spectrum which had to be observed.

At first the inquiry appeared hopeless, from the circumstance that the brightest line in the nebular spectrum is not sufficiently coincident in character and position with the brightest line in the spectrum of nitrogen to permit this line to be used as a fiducial line of comparison. The line in the spectrum of the nebulæ is narrow and defined, while the line of nitrogen is double, and each component is nebulous and broader than the line of the nebulæ. The nebular line is apparently coincident with the middle of the less refrangible line of the double line of nitrogen.*

* Proceedings of the Royal Society, vol. xx. p. 392.

The third and fourth lines of the nebular spectrum are undoubtedly those of hydrogen, but their great faintness makes it impossible to use them as lines of comparison under the necessary conditions of great dispersive power, except in the case of the brightest nebulæ.

The second line, as I showed in the paper to which I have referred, is sensibly coincident with an iron line, wave-length 495·7; but this line is inconveniently faint, except in the brightest nebulæ.

In the course of some other experiments my attention was directed to a line in the spectrum of lead which falls upon the less refrangible of the components of the double line of nitrogen. This line appeared to meet the requirements of the case, as it is narrow, of a width corresponding to the slit, defined at both edges, and in the position in the spectrum of the brightest of the lines of the nebulæ.

In December 1872 I compared this line directly with the first line in the spectrum of the Great Nebulæ in Orion. I was delighted to find this line sufficiently coincident in position to serve as a fiducial line of comparison.

I am not prepared to say that the coincidence is perfect; on the contrary, I believe that if greater prism power could be brought to bear upon the nebulæ, the line in the lead spectrum would be found to be in a small degree more refrangible than the line in the nebulæ.

The spectroscope employed in these observations contains two compound prisms, each giving a dispersion of 9° 6′ from A to H. A magnifying-power of 16 diameters was used.

In the simultaneous observation of the two lines it was found that if the lead line was made rather less bright than the nebular line, the small excess of apparent breadth of this latter line, from its greater brightness, appeared to overlap the lead line to a very small amount on its less refrangible side, so that the more refrangible side of the two lines appeared to be in a straight line across the spectrum. This line could be therefore conveniently employed as a fiducial line in the observations I had in view.

In my own map of the spectrum of lead this line is not given. In Thalén's map (1868) the line is represented by a short line to show that, under the conditions of spark under which Thalén observed, this line was emitted by those portions only of the vapour of lead which are close to the electrodes.

I find that by alterations of the character of the spark this line becomes long and reaches from electrode to electrode. As some of those conditions (such as the absence of the Leyden jars, or the close approximation of the electrodes when the Leyden jars are in circuit) are those in which the lines of nitrogen of the air in which the spark is taken are faint or absent, the circumstance of the line becoming bright and long, or faint and short inversely, as the line of nitrogen suggested to me the possibility that the line might be due not to the vapour of lead but to some combination of nitrogen under the presence of lead vapour. As, however, this line is bright under similar conditions when the spark is taken in a current of hydrogen, this supposition cannot be correct.

A condition of the spark may be obtained in which the strongest lines of the ordinary lead spectrum are scarcely visible, and the line under consideration becomes the strongest in the spectrum, with the exception of the bright line in the extreme violet.

I need scarcely remark that the circumstance of making use of this line for the purpose of a standard line of comparison is not to be taken as affording any evidence in favour of the existence of lead in the nebulæ.

Each nebula was observed on several nights, so that the whole observing time of the past year was devoted to this inquiry. In no instance was any change of relative position of the nebular line and the lead line detected.

It follows that none of the nebulæ observed show a motion of translation so great as 25 miles per second, including the earth's motion at the time. This motion must be considered in the results to be drawn from the observations; for if the earth's motion be, say, 10 miles per second from the nebulæ, then the nebula would not be receding with a velocity greater than 15 per second; but the nebula might be approaching with velocity as great as 35 miles per second, because 10 miles of this velocity would be destroyed by the earth's motion in the contrary direction.

The observations seem to show that the gaseous nebulæ as a

* Proceedings of the Royal Society, vol. xx. p. 380.

class of bodies have not proper motions so great as many of the bright stars. It may be remarked that two other kinds of motion may exist in the nebulæ, and if sufficiently rapid, may be detected by the spectroscope. 1. A motion of rotation in the planetary nebulæ which might be discovered by placing the slit of the instrument on opposite limbs of the nebulæ. 2. A motion of translation in the visual direction of some portions of the nebulous matter within the nebula, which might be found by comparing the different parts of a large and bright nebula.

Sir William Herschel states that "nebulæ were generally detected in certain directions rather than in others, and the spaces preceding them were generally quite deprived of stars; that the nebulæ appeared some time after among stars of a certain considerable size, and but seldom among very small stars; that when I came to one nebula I found several more in the same neighbourhood, and afterwards a considerable time passed before I came to another parcel." *

Since the existence of real nebulæ has been established by the use of the spectroscope, Mr. Proctor † and Prof. D'Arrest ‡ have called attention to the relation of position which the gaseous nebulæ hold to the Milky Way and the sidereal system.

It was with the hope of adding to our information on this point that these observations of the motions of the nebulæ were undertaken.

In the following list the numbers are taken from Sir J. Herschel's "General Catalogue of Nebulæ." The earth's motion given is the mean of the motions of the different days of observation.

No.	h.	H.	Others.	Earth's motion from Nebulæ.
1179	360	—	M. 42	7 miles per second.
4234	1970	—	Σ. 5	12 ,, ,,
4373	—	IV. 37.	—	1 ,, ,,
4390	2000	—	Σ. 6	2 ,, ,,
4447	2023	—	M. 57	3 ,, ,,
4510	2047	IV. 51.	—	14 ,, ,,
4964	2241	IV. 18.	—	13 ,, ,,

Chemical Society, April 2.—Prof. Odling, F.R.S., in the chair.—A paper on Sulpho-cyanide of Ammonium and Sulphocyanogen, by Dr. T. L. Phipson, and a note On a Reaction of Gallic Acid, by H. R. Procter, were read by the Secretary. Mr. Procter finds that a mixture of gallic acid and potassium arsenate, when exposed to the air, acquires a beautiful green colour.—Mr. W. Noel Hartley then read a memoir On Cobalt Bromides and Iodides, in which he described the method of preparation and properties of these compounds; they closely resemble the corresponding chlorides. Fine specimens of the different salts were exhibited by the author.—Mr. E. Neison read a paper On the Distillation of Sodium Ricinoleate, and Mr. C. H. Piesse a note On the Solubility of Plumbic Chloride in Glycerin.—Mr. Kingzett read a voluminous communication On Ozone as a Concomitant of the Oxidation of the Essential Oils, Part I., and from his experiments he infers that the compound produced during the oxidation of oil of turpentine is neither ozone nor hydrogen peroxide, but a hydrated oxide of turpentine. The last paper was On the Action of Chloride of Benzyl on Camphor, Part II., by Dr. D. Tommasi.

Royal Microscopical Society, April 1.—F. H. Wenham, vice-president, in the chair.—A paper On the Structure of the Lepisma Scale, by Dr. Anthony, was read to the meeting, in which the author showed that the two sets of markings were upon opposite sides of the scale, the ribs being upon the under side.—Mr. Wenham gave a demonstration of his method of measuring the angular apertures of objectives, and explained his mode of stopping out the extraneous rays which were so frequently a cause of error.—Mr. S. J. McIntire read a paper describing the proboscis of a moth (believed to be a South African species) which was furnished with a means of perforating the nectaries of flowers. A mounted specimen was exhibited under one of the Society's instruments in the room, and drawings in illustration of the paper were placed upon the table.

Linnean Society, April 2.—Mr. J. Gwyn Jeffreys, F.R.S., in the chair.—On the Morphology of the Skulls in the Woodpeckers (*Picidæ*) and the Wrynecks (*Yungidæ*), by Mr. W. Kitchen Parker, F.R.S. The present paper is one of a series in hand in which the writer has endeavoured to work out thoroughly the facial characters of certain types of birds in harmony with the views given by Prof. Huxley in his well-known paper on the Classification of the Feathered Types (Zool. Proc. April 11, 1867). His own mode of research is much more like that followed by the distinguished author of that paper than that pursued by ornithologists proper. Without undervaluing their excellent labours, there are many things which are seen first and first understood by the embryologist and not by the zoologist as such. Prof. Huxley, in the paper just referred to, separated the forms now under consideration into his group Coleomorphæ, and gives (p. 467) a very valuable summary of their characters. It was sought in that paper to bring into more or less zoological contiguity such birds as have a similar structure of the facial, and especially of the palatal, bones. Those group-terms, the Schizognathæ (p. 426), the Dromæognathæ (p. 425), &c., are very important, although some of them are of very wide application. It was the first thought of the author of this paper that the woodpeckers would easily find a place amongst the *non-passerine* aërial birds; but examination of their palatal structures soon dispelled this opinion. They are more allied to the Passerinæ than most of the Zygodactyles; but it is to the *embryos* of that type, and not to the adult, that they are related. The Passerinæ themselves are well termed ægithognathous (p. 450); this huge group is under hand at present. Most of the non-passerine birds that seem to come nearest to the woodpeckers have a very solid palate; they are desmognathous; others, as the humming-birds and goatsuckers (*Caprimulgus*), are schizognathous; whilst the swift (*Cypselus*) is as perfectly ægithognathous as the swallows. But the woodpeckers retain that non-coalescent condition of the palatal structure which we see in the lizards, very unlike that great fusion of parts towards the mid-line which occurs in most of the higher birds. They also have an unusally arrested condition of the palatal part of the upper jaw-bone (maxillary), which is characteristic of the lizard and unlike the bird-class generally, and bones superadded to the palate, vomers, septomaxillaries, &c.; these are persistently in paired groups, more in number, and altogether more evidently embryonic and Lacertian, than the homologous parts of other birds. The writer therefore seeks to introduce a new morphological term for these birds as a group, having relation to their face, namely, the term Saurognathæ; for none of Prof. Huxley's terms are appropriate for this type of palate. The writer has worked out these parts in the nestling of *Yunx torquilla*, in four stages of *Gecinus viridis*, in the young of *Picus minor*, and in the adult of *P. major*, *P. analis*, *Hemilophus fulvus*, and *Picummus minutus*.

MANCHESTER

Literary and Philosophical Society, March 3.—*Physical and Mathematical Section*.—Alfred Brothers, F.R.A.S., president of the Section, in the chair.—Results of Rain-Gauge Observations at Eccles, Manchester, during the year 1873, by Thomas Mackereth, F.R.A.S.

March 10.—Ordinary Meeting.—E. W. Binney, F.R.S., vice-president, in the chair.—The chairman said that at a meeting of the Society on January 9, 1872, in presenting to the notice of the members specimens of fossil woods from the lower coal measures of Lancashire, he stated "that from some examples in his cabinet he was led to believe that Cotta's *Medullosa elegans* was merely the rachis of a fern or a plant allied to one." Prof. Renault, of Paris, to whom we owe so much for his researches in fossil botany, read a memoir before the French Academy on January the 26th last, which has since been printed in the *Comptes Rendus*, that completely confirms this opinion.—Further Observations and Experiments on the Influence of Acids on Iron and Steel, by William H. Johnson, B.Sc. At the last meeting of the Society Prof. Reynolds, in an interesting paper On the Effect of Acid on the Interior of Iron Wire, appears to think that Mr. Johnson did not attribute to hydrogen any portion of the remarkable change produced in iron and steel by immersion in acid. That immersion in acid is the primary cause no one, Mr. Johnson thinks, will dispute; but that hydrogen plays an important part in producing these changes and is the cause of the bubbles, the author showed in a paper read before the Society, March 4, 1873. The supposition that the absorption of hydrogen is the sole cause of the change in the breaking strain, diminution in toughness, &c., attendant on the immersion of iron in hydrochloric or sulphuric acids, and that there is no absorption of

* Philosophical Transactions, 1784, p. 448.
† "Other Worlds than Ours," pp. 280–290.
‡ "Astronomische Nachrichten," No. 1908, p. 190.

these acids into the interior of the iron, does not account for a number of phenomena that have been observed so often and so carefully as to leave no doubt of their invariable recurrence if the conditions of experiment be only properly observed. It seems to the author that the only satisfactory way of explaining all the phenomena is to suppose that when a piece of iron is immersed in acid two actions go on, viz.: an absorption of the nascent hydrogen into the interior of the iron, which hydrogen may subsequently be given off by gentle heat or immersion in a liquid, &c. Secondly, an absorption of the acid itself, possibly in a very concentrated form, by the insterstices between the fibres or crystals of the metal. It will however be said, the acid must act on the walls of the cavity and form a salt of iron with liberation of hydrogen. This may go on to a small extent, but in opposition to this view we may bring the experiments of Prof. Bequerel on solutions separated by a cracked tube (*Comptes Rendus*, lxxvi.), where he shows that no precipitate is formed on placing a cracked tube filled with nitrate of lead in a solution of potassium sulphate within the crack, thus making it probable that chemical interchanges do not take place in very minute spaces. By this theory we may easily explain the decrease in toughness after immersion in acid. For toughness implies a certain ease of mobility of the particles. When a piece of iron is bent the particles of one side are compressed, thus diminishing the minute cavities between the fibres, while those of the other side are stretched, and the minute cavities elongated. If we fill these cavities with a liquid this mobility of the particles is prevented, for the cavities cannot now be diminished in size and the compression of the one side cannot now take place, consequently the piece tears or breaks off just like a piece of frozen rope. It will also explain the acid reaction of the moistened fracture, and further, as hydrochloric acid is much more volatile and of less specific gravity than sulphuric acid, it is only natural to expect that the effect of immersion in hydrochloric acid will pass off more rapidly than of immersion in sulphuric. This experience fully confirms. The author then gives details of a number of experiments and their results bearing on the point under discussion.—Results of certain Magnetic Observations made at Manchester during the year 1873, by Prof. Balfour Stewart, F.R.S.

GLASGOW

Geological Society, March 12.—A paper was read On some Polyzoa from the carboniferous limestone shales near Glasgow, by Prof. Young, F.G.S., and Mr. John Young, vice-president. The authors described a new genus which they had established under the name of *Rhabdomeson*, and which includes at least two species hitherto referred to *Ceriopora*, namely, *C. gracilis* and *C. rhombifera*. The authors also described and exhibited specimens of other two species of polyzoa, the one having the habit of a *Fenestella*, the other of a *Glauconome*, but both showing the remarkable peculiarity of a series of eight denticles projecting horizontally over the cell aperture. For the fenestrated species, they proposed to constitute a new genus—*Stellipora*. The other they retained, meantime, in the genus *Glauconome*.—Mr. Robert Craig read a paper, the first of a series, On the Fossils found in the carboniferous beds around Beith and Dalry, with special reference to the position of their first appearance in the beds. These beds, he remarked, are highly fossiliferous, and occur in the following general order:—(1) Lower limestone, resting upon volcanic ash, 17 fathoms; (2) coal and ironstone measures, resting upon the lower limestone, above 100 fathoms; (3) upper limestone, taking the Swindridge or Highfield "post" as the lower stratum, about 65 fathoms. Mr. James Dairon read a paper on a new species of Retiolites (*Retiolites fibratus*) found by him last summer in the Moffat shales of the Lower Silurian system of the South of Scotland.

PARIS

Academy of Sciences, March 30.—M. Bertrand in the chair. M. de Quatrefages presented to the Academy the second part of his work (written in conjunction with M. Hamy, assistant naturalist in the Museum) entitled "*Crania ethnica*. The skulls of the human races." The author made additional remarks on fossil human races, calling attention in particular to the race of Cro-Magnon. The characters of this race are well exemplified in the male and female remains discovered at Cro-Magnon in 1868. The male skull is remarkable for its capacity, gauging, according to M. Broca, not less than 1,590 cent. cubes, a number sensibly above the mean of all European populations. With the Cro-Magnon remains the authors class several other specimens of human fossils from the same valley of Vézère, from Bruniquel (caves of Lafaye and Forges), from the south towards the Pyrenees (the cave of Aurignac), and from the cave of Gourdon near Montréjeau. The same race is traced in the Menton skeleton and beyond the Alps in the Cantalupo skulls and in that from Isola del-Liri. In France again male skulls of the same race have been excavated in Mâconnais and Grenelle, while Liège has furnished the celebrated Engis skull. During the quaternary epoch it appears therefore that the Cro-Magnon race had its head-quarters in the south-west of France, particularly in the valley of Vézère, where the intellectual development can be traced from station to station, possibly to the confines of civilisation. The authors think it probable that the earliest representatives of the race will be found in Africa.—M. Pasteur made some verbal observations on M. A. Guerin's recent communication on the pathogenetic rôle of ferments in surgical maladies.—On an apparatus invented by M. Moncoq for the operation of transfusion of blood, by M. Bouley.—On the hydrometric service of the basin of the Seine, by M. Belgrand.—MM. Daubrée and Brongniart presented a report on M. Renault's memoir, entitled "Study of the Genus *Myelopteris*." The reporters consider the conclusions arrived at of sufficient importance to warrant the publication of the memoir in the collections from foreign *savants*.—On the integration of equations to the partial derivatives of the second order, by M. A. Picart.—On the artificial production of the phenomena of gaseous thermo-diffusion of leaves by means of moist porous and pulverulent bodies, by M. Merget. The author concluded by observing that the dynamical utilisation of thermo-diffusive forces would resolve in a simple manner the problem of the direct transformation of solar heat (energy ?) into mechanical work.—On some general facts which arise from comparative androgenesis, by M. A. Chatin.—Observations on the disposition of the fibro-vascular bundles in leaves, by M. J. L. de Lanessan.—On a method of photographic enlargement for astronomical observations, by M. C. Zenger. The method proposed is likely to be of service in photographing the forthcoming transit of Venus. The author uses a mirror of long focus instead of a lens to produce the sun's image, and to prevent errors of irradiation and inflexion, proposes to photograph the planet at its moment of passage across a point *h* of a particular meridian of the sun, The enlarging process suggested corrects aberration in the original photograph.—On an electro-automatic whistle for locomotives, by MM. Lartigue and Forest.—On the employment of luminous signals in geodesic operations, by M. Laussedat.—The analysis (mathematical) of an armed and closed electro-magnetic circuit proves that electric induction does not traverse conducting masses, by M. P. Volpicelli.—On the movement of air in pipes, by M. C. Bontemps.—On the action of ammonia on acetone, by MM. Œchsner and Pabst. The authors believe that the reaction gives rise to Staedeler's *acetonine*.—On Egyptian blue, by M. H. de Fontenay.—Experimental researches on the influences which changes of barometrical pressure exert on the phenomena of life, 13th note, by M. P. Bert.

CONTENTS