THURSDAY, FEBRUARY 8, 1883

ZOOLOGICAL SKETCHES

Zoological Sketches. A Contribution to the Out-door Study of Natural History. By Felix L. Oswald. With Thirty-six Illustrations by Hermann Faber. (London: W. H. Allen and Co., 1883.)

Zoological Notes on the Structure, Affinities, Habits, and Mental Faculties of Wild and Domestic Animals; with Anecdotes concerning and Adventures among them; and some Account of their Fossil Representatives. By Arthur Nicols, F.G.S., F.R.G.S. Illustrated by J. W. Wood and F. Babbage. (London: L. Upcott Gill, 1883.)

WE cannot say much in favour of the first of these two works. The engravings are good, but the subjects chosen scarcely justify the care which has been taken in their execution. For these subjects are nearly all chosen for the sake of a comical or sensational effect, without any reference to utility as illustrating zoological facts or principles. And the essentially unscientific spirit which has led to the choice of the "thirty-six illustrations," is no less apparent throughout the letter-press. We are always ready to welcome any attempt at popularising zoology, more especially when the writer has any first-hand "contributions to the study of natural history" to supply; but surely such study admits of being made sufficiently interesting in itself, without the need of lame attempts at a kind of pleasantry, which in being always forced and never witty, must necessarily become irksome even to the least intelligent of unintelligent readers. We are the more disposed to regret the author's mistake in adopting this artificial style, because in his short preface, where it is not adopted, he shows that he is able to write with marked ability.

Concerning the facts of natural history which are detailed, the most interesting, in our opinion, are those which refer to the intelligence of monkeys and the stupidity of sloth bears. We shall, therefore, give one quotation on each of these topics.

Speaking of a domesticated sloth, the author says:—

"Though fed daily by the same hands, the old pensioner still fails to identify his benefactor, or to recognise his obligations in any way. To his ear the human voice in its most endearing tones is a grunt *et præterea nihil;* you might as well appeal to the affections of a cockroach. You may frighten a pig, a goose, a frog, and even a fly, but you cannot frighten or surprise a sloth. On my last trip to Vera Cruz I procured a pair of black tardos, full grown, and in a normal state of health, so far as I could judge, but after a series of careful experiments I have to conclude that their instinct of self-preservation cannot be acted upon through the medium of their optic or acoustic nerves. They can distinguish their favourite food at a distance of ten or twelve yards, and the female is not deaf, for she answers the call of her mate from an adjoining room; but the approach of a ferocious-looking dog leaves her as calm as the sudden descent of a meat-axe within an inch of her nose. The he-sloth witnessed the accidental conflagration of his straw couch with the coolness of a veteran fireman. War-whoops do not affect his composure. I tried him with French-horn blasts and detonating powder, but he would not budge. One of my visitors exploded some pyrotechnic mixtures of wondrous colours and odours, but the tardo declined to marvel; he is a *nil-admirari* philosopher of the ultra-Horatian school."

Very different was the philosophical temper displayed by another of the author's pets. This was a young Siamese bonnet-macque monkey (*Macacus radiatus*), of which he says:—

"His conduct under circumstances to which no possible ancestral experiences could have furnished any precedent has often convinced me that his intelligence differs from the instinct of the most sagacious dog as essentially as from the routine knack of a cell-building insect. His predilection for a frugal diet equals that of his Buddhistic countrymen, and I have seen him overhaul a large medicine-chest in search of a little vial with tamarind jelly. He remembered the shape of the bottle, for he rejected all the larger and square ones, and after piling the round ones on the floor, began to hold them up against the light, and sub-divide them according to the fluid or pulverous condition of their contents. Having thus reduced the number of the doubtful receptacles to something like a dozen and a half, he proceeded to scrutinise these more closely, and finally selected four, which he managed to uncork by means of his teeth. Number three proved to be the bonanza bottle, and, waiving all precautions in the joy of his discovery, Prince Gautama left the medical miscellanies to their fate, and bolted into the next room to enjoy the fruits of his enterprise."

We have only observed one actual error in natural history, but as it is frequently repeated, we may point it out. The writer speaks of vampire bats as those which suck the blood of sleeping persons, whereas the truth is, as Belt has remarked, "the vampire is the most harmless of all bats."

The over-burdened title of the second of the above-named books serves to show its general character. The author is known from his previous works on "Chapters from the Physical History of the Earth," "The Puzzle of Life, and How it has been Put Together," &c. He is therefore already known as an ardent sportsman, a good naturalist, and an accurate observer; but in our opinion his latest work is his best. Indeed, we have seldom read a more successful and entertaining account of wanderings in which science has been combined with sport. Whether Mr. Nicols is writing about the snakes of India, the marsupials and monotremata of Australia, or the birds of South America, he manages equally to convey such vivid and interesting pictures of the animals, with their habits and surroundings, that while not a few of his first-hand observations are of importance to the scientific zoologist, nearly every page of his book is delightful and instructive to the general reader.

The plan of his work is a simple one. The first four chapters are devoted to Snakes, the second four to Marsupials, and the remaining eleven to Birds. In each case all the more interesting features of classification, anatomy, development, habits, distribution, intelligence, &c., are given with accuracy, and sandwiched between very readable descriptions of scenery, sporting adventure, &c. As an example of the latter, we may give one quotation, and for this purpose we choose one of the scenes in Australia:—

"On every side was desolation and salt-saturated earth, but here, in the midst of it, stately trees, luxuriant vegetation, and, above all, fresh water! This delightful site was selected by myself and my friend as a camping ground for a fortnight's holiday in the height of summer. Beyond a few pounds of biscuit and the usual allowance of tea and sugar, we had nothing, intending to live on whatever the gun and fishing-line brought to bag, and pick up as much natural history as possible. At a short distance from camp a creek entered the bay, noted for the abundance of wild fowl to be found upon it in the autumn and winter; but now all the birds were away breeding in the vast impenetrable swamps to the southward of the bay, except a few barren or unmated stragglers. . . . The sole result of the day's sport had been a pelican and a small shark, obtained in the first hour after sunrise, when alone it was possible to face the heat. Neither of us being acquainted with the method (if any exist) of rendering pelican a culinary delicacy, and having made the acquaintance of fried shark to such purpose that we would not willingly renew it, nothing remained but to watch for a chance duck. This duty being allotted to me, while my companion prepared the tea, I placed myself towards evening in hiding behind a mangrove stump, with the retriever beside me. For nearly an hour I endured the torture of a mosquito assault on face, hands, and legs, when suddenly a duck turned the seaward bend of the creek, and came skimming along the water to me. I stepped forward and shouted at him, with the usual result of making him hesitate in his flight and rise well into the air, exposing the lower and most vulnerable side of his body to the charge, which in another instant laid him dead upon the water. The retriever dashed in to do his part of the work, and our supper might have been considered secure, had not a swift-winged cloud passed between the very nose of the dog and the bird, and with a splendid swoop a sea eagle bore off the duck, grasped by one strong foot. The sudden and unexpected action deprived me momentarily of all thought but admiration for the consummate ease and grace of a movement performed without any apparent effort, yet so expressive of immense power."

Among the novel or otherwise interesting observations in natural history which are recorded, we may note the following. The young kangaroo, while carried in the pouch of its mother, swallows the nipple, the end of which rests in the stomach; if forcibly withdrawn, the young animal makes no attempt to regain it, nor does it seem to have any idea where to seek for it. Again, speaking of Prof. Owen's theory concerning the object of the pouch as a "perambulator," necessitated by the long droughts in Australia to enable the mother to carry about her young in her search for water, Mr. Nicols observes that this view can only at best apply to the case of kangaroos, and therefore can scarcely be taken as the true *raison d'être* of the marsupium. Moreover, as a matter of fact, the "arboreal marsupials *do not* migrate in the severest drought, and in all probability they depend entirely upon the copious dew which falls at night upon leaves and grass."

The following observation on the king lory seems worth quoting:—

"In a few minutes he flew on to a tree well within range of the binocular, and shortly afterwards a female joined him in answer to his call. The swain was ardent, the damsel coy; they flitted from branch to branch, and whenever she perched he circled round her, threw himself underneath the branch, and swung to and fro with outspread wings, displaying the full glory of his scarlet breast. In every movement, whether on the wing or swaying at the end of a bough, he studied to present in the most effective manner the brilliant adornments of his plumage. . . . I do not think it possible for any one who had seen this little episode in bird life to have resisted the conclusion that the male was conscious of his beautiful breast, and that he adopted the best method of showing it by swinging himself beneath the branch, whence the female could look down and admire the display."

In the course of a discussion on the theory of flight Mr. Nicols has occasion to correct several errors of observation which have been made by previous writers. Thus, Captain F. W. Hutton has said that he has "sometimes watched narrowly one of these birds (albatross) sailing and wheeling about in all directions for more than an hour without seeing the slightest movement of the wings"; and the Duke of Argyll, in his "Reign of Law," repeats the statement, on the testimony, as he says in reply to a letter from Mr. Nicols on the subject, "of many writers and of some friends." But Mr. Nicols is very positive in his assertion that "the soaring does not continue for more than four minutes without a wholly new departure of from twenty to thirty powerful wing impulses, and it would seem an importation of the supernatural into Natural History to admit the possibility of sustaining the [soaring] flight for an hour." Mr. Nicols also questions the accuracy of another statement which was published by the Duke in this Journal concerning the habits of *Picus minor*. His Grace said that, having had an opportunity of closely observing these habits, he found that the cock bird drums upon the hollow parts of trees with his beak, in order to produce "instrumental music" wherewith to charm the sitting hen. On this it is remarked—

"The above is dated May, 1880. Although everything from the pen of so attentive an observer will be received with respect, it must obviously be very difficult to determine whether this is really a substitute for vocal music, or simply the ordinary beating of the tree to procure food."

We shall now conclude this brief selection from Mr. Nicols' observations, by quoting a somewhat remarkable one which he made in the Zoological Gardens of London.

"I saw a most extraordinary performance on the part of a flamingo towards a *cariama*. The two birds were in adjoining pens in the open air, separated by close wire fencing, over which the flamingo could easily reach. The cariama was constantly uttering its harsh metallic cry while standing opposite to the flamingo, both birds being as near the fence as they could stand. They remained gazing at each other thus for at least half an hour, each replying to the cry of the other. The demeanour was not in the least suggestive of anger, but what passion moved the flamingo I cannot imagine, unless it had some reference to the sexual instinct, and may indicate a habit unknown to naturalists. During the whole time that I watched them—and perhaps for long before and after—the flamingo continued to drop from its beak upon or in front of the cariama a bright scarlet fluid, which I cannot doubt was blood. The bird was certainly not wounded or hurt, and the action, from whatever impulse it proceeded, was voluntary, and appeared to afford gratification to the performer and to the recipient of this singular attention. In reply to a note on the subject, which I at once sent to Mr. Darwin, he expressed his surprise at the peculiar behaviour of the flamingo, which had not previously been brought under his notice, but did not see his way to an explanation of it. The keeper told me he had witnessed the performance once before, and assured me that both birds were in perfect health, and on most friendly terms with each other."

From the care with which Mr. Nicols has made most of his other observations, we should have expected him in this case to have procured some of this scarlet fluid for examination, and also to have obtained permission to place both birds in the same pen; but we have said enough to show that his book seldom lays itself open to criticism of this kind, and we sincerely hope that it will, in the words of its concluding sentence, "find favour with the public," not only because it well deserves to do so, but also because the author promises that if it does, other Series of similar Zoological Notes will be issued by him from time to time. Lastly, we must not take leave of this, the First Series, without noticing the life-like drawings of the illustrations —particularly that of the cobra—and also the novel and effective character of the binding, the boards being covered with thin but continuous plates or shavings of wood, which, without at all adding to their stiffness, give so strikingly pretty a finish that we should like to see this new idea in book-binding largely adopted by other publishers. GEORGE J. ROMANES

THE GOLD COAST

To the Gold Coast for Gold. By Richard F. Burton and Verney Lovett Cameron. Two Vols. Maps and Illustrations. (London: Chatto and Windus, 1883.)

THE exploration undertaken by Captains Burton and Cameron was for the purpose of examining and reporting upon the condition and prospects of certain gold-mining properties in Western Africa, for which early in 1882 upwards of seventy distinct concessions had already been obtained from various native owners. Five only out of these concessions are reported on as having upon them mines actually in operation, while it is more than probable that of the remaining sixty-five a large proportion might be acquired by the British public for a valuable consideration.

It had originally been intended to explore the so-called Kong Mountains, relative to which no additional information has for many years been acquired; but so much work had to be accomplished on the Ancobra river that the latter portion of the programme had of necessity to be relinquished; under this disappointment Capt. Burton philosophically consoles himself with the reflection that "Geography is good but Gold is better.'

Capt. Burton left Trieste on November 18, 1881, for Gibraltar, and thence proceeded to Madeira, about which he very pleasantly gossips through some sixty pages, and where he is joined, on January 8, 1882, by his travelling companion, Capt. Cameron. From Madeira they proceed together to Teneriffe, *à propos* of which place we are given the translation of a Spanish account of the repulse of Lord Nelson from Santa Cruz de Teneriffe, which extends through at least another fifty pages.

From Teneriffe the travellers continued their voyage, touching at Bathurst, Sierra Leone, Cape Palmas, &c., eventually landing at Axim on January 24, 1882. Of Axim Capt. Burton says:—

"There is no better landing-place than Axim upon this part of the African coast. The surf renders it impracticable only on the few days of the worst weather. We hugged the north of the Bobowusúa rock-islet. When the water here breaks there is a clear way further north; the southern passage, paved with rocks and shoals, can be used only when the seas are at their smoothest. A regular and well-defined channel placed us on the shingly and sandy beach. We had a succulent breakfast with Messrs. Gillet and Selby (Linott and Spink), to whose unceasing kindness and hospitality we afterwards ran heavily in debt. There we bade adieu to our genial captain and our jovial fellow-travellers."

From Axim the travellers visited a stretch of country in the vicinity of the coast, extending some distance west of that town, and Prince's River to the east of it; and then ascended the Ancobra as far as Tumentu, situated about twenty-two miles from its mouth. After inspecting this last locality Capt. Burton returned to Madeira, leaving Capt. Cameron to continue his surveys inland as far as Crockerville, a mining settlement about forty-five miles north-east of Axim. Capt. Cameron left the African coast on March 28, 1882, and having picked up Capt. Burton at Madeira they proceeded together to Liverpool.

Rich alluvial deposits as well as auriferous quartz reefs are described as occurring abundantly, but the hydraulicing of the former is strongly recommended in preference to the mining and crushing of the latter. This opinion is so constantly reiterated that the explorers would appear to believe that a large portion of the "Dark Continent" would pay for washing. Water is stated to be plentiful, and facilities for hydraulic mining are represented as being very general.

"Wherever *catas* or 'women's washings' are found we can profitably apply the hydraulic system of sluicing and fluming, not by an upper reservoir only, but also from below, by a force pump. Water is procurable at all seasons by means of Norton's Abyssinian tubes, and the brook-beds dammed above and below will form perennial tanks."

In California as much as fifteen hundred and seventy cubic feet, or forty-three tons of water, under a pressure of four hundred feet, are sometimes discharged per minute from a single nozzle; it is therefore evident that any supply to be obtained from Abyssinian tubes, and pumped against an auriferous bank, would, in comparison with such a power as that described, possess only the force of an ordinary garden squirt.

About five-sixths of the letterpress are from the facile pen of Capt. Burton, the remainder being contributed by his companion, who appears to have done good work by determining the position of various places, of which the exact situation was previously unknown. Collections of plants and birds were also made.

Although somewhat diffuse, these volumes contain much information very pleasantly conveyed, but even in the case of gold-mining, caution is often to be recommended.

OUR BOOK SHELF

A Handbook of Vertebrate Dissection. By H. Newell Martin, D.Sc., M.D., M.A., and William A. Moule, M.D. Part I. How to Dissect a Chelonian. (New York: Macmillan and Co., 1881.)

SINCE the publication of Huxley and Martin's "Elementary Biology," there has been a growing want of more books constructed on the same model. Without such books it is exceedingly difficult for a student to dissect and thoroughly understand the anatomy of an animal which he has never examined before; and though many of the large teaching centres have their own laboratory directions, which, with the help of demonstrators, fulfil all requirements, there are few reliable practical books which can be bought by the private student.

Drs. Martin and Moule have lately brought out a pamphlet in which full directions are given "how to dissect a Chelonian," and we are pleased to see from the preface that they intend to follow it by a series of similar works. It is almost a pity that so exceedingly specialised a reptile as a Chelonian should be the first they treat, especially as they intend to include a lizard in the series, for it is doubtless far better to begin the study of reptiles with the latter than with the former.

The species on which the work is based is *Pseudemys rugosa*, but, as Dr. Martin states, "the end in view is not to provide a monograph on any one species, but to show a student 'how to dissect a Chelonian,'" the fact that, when dissecting another species, the description in the book cannot altogether be relied upon, makes the student examine everything carefully for himself.

Without working through the anatomy of a Chelonian with the help of the book it is impossible fully to appreciate its value, but from the arrangement, accuracy, and clearness of description, it will doubtless prove a great boon to the young herpetologist.

The only fault we can find with it is one under which the "Elementary Biology" equally suffers, and that is the want of illustrations. There is a frontispiece with four rather rough woodcuts of the skull (to which no reference letters are given in the text), but this is all.

Of late several illustrated students' biological books, intended as guides for practical work, have been brought out, but most of these are so inaccurate as to be practically useless. It is therefore to be regretted that a book by so eminent a teacher as Dr. Martin should be so poorly provided with figures, and we hope that the rest of the series will be more fully illustrated, as their value would be thereby greatly increased.

Ferns of Kentucky. By John Williamson. (Louisville, Kentucky: J. P. Morton and Co., 1878).

ALTHOUGH this little volume has only just reached us, it cannot be said to be out of date; for the number of popular works on ferns—those published in England excluded—is so small, that an addition to their number is at any time welcome to the fern-lover who has become well acquainted with the common British species, and would gladly increase his knowledge of the tribe. There is, indeed, no parallel in French or German literature to the number of fern-books which have been issued in England; but it would appear from the volume before us that in America fern-hunting is as popular as it is among ourselves; for Mr. Williamson asks in his preface "Who would think now of going to the country to spend a few days, or even one day, without first inquiring whether ferns are to be found in the locality?"

Mr. Williamson has given descriptions of the species found in Kentucky, and the letterpress is accompanied by sixty plates, in which the characters of the genera and the habit of each species is represented. The descriptions, although short and couched in simple language, seem carefully done; and the absence of pretence about the work does not render it the less attractive. Although, of course, primarily intended for local use, the "Ferns of Kentucky" contains much to interest the British lover of ferns.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Hovering of Birds

I AM much obliged to his Grace the Duke of Argyll and to Mr. H. T. Wharton for the notice they have taken of my letter on the hovering of birds. It may be hoped that the question will not be allowed to rest until it has received its quietus at the hands of some mathematician who shall tell us with authority whether it is possible, according to the received laws of mechanics, for a rigid body, by any disposition of its surfaces, to remain motionless (relative to the earth) for a minute in mid-air in a perfectly horizontal wind.

It is disappointing to find that the 3rd chapter of the "Reign of Law," to which the Duke refers me, contains no satisfactory explanation of the phenomenon of motionless hovering. We read there (p. 161, 5th edition, 1868). "When there is a strong breeze, no flapping is required at all, the force of the wind supplying the whole force necessary to counteract the force of gravity." This is hardly a sufficient explanation. Let us imagine a bird at rest in a horizontal wind. Neglecting friction, the only forces acting on the bird are (1) the vertical force of gravity, and (2) the resultant of the air-pressures on the different surfaces of the bird caused by the horizontal velocity of the wind. These pressures may be resolved parallel and perpendicular to the general plane of the wings, and the direction of their resultant will vary with the slope of the wing-plane; but in every case it will lie to rearward of the vertical, and therefore in every case there will be a resolved horizontal force pushing the bird backwards. Yet in spite of this force the bird is to remain at rest! Shade of Archimedes!

Consider, again, what must be the necessary corollary to the Duke's proposition. If a bird can remain at rest in a horizontal wind, it necessarily follows that in still air a bird can float horizontally without losing velocity. We do indeed see rooks and other birds float long distances descending on outspread wings in still air, and it is marvellous how slow is the descent, so great is the resistance of air to a plane surface when at every successive instant the plane surface covers a fresh body of air that has not yet begun to yield. But no one ever saw a bird maintain a horizontal floating flight in still air. Either the descent is continuous, or the bird loses velocity.

It might be wished, in a matter of such importance, involving as it does nothing less than the establishment of a miracle, that the Duke of Argyll were more precise in his statement, for I feel curious to know by what resolution of forces he would demonstrate the existence of a forward horizontal force to balance the backward force which he cannot deny to be present. A diagram setting forth the Duke's views would be exceedingly welcome. My own diagram, I fear, will not serve his purpose any better than my words, in spite of the attempt he makes to press them into his service. The Duke says: "The bird has only to slope his wing-surfaces to the [horizontal] current, and precisely the same effect is produced as if the current had been otherwise sloped upwards against a horizontal wing-surface." Perfectly true, provided his Grace can tilt the direction of gravity through the same angle. Otherwise not (at the same time there is nothing about a "horizontal wing surface" in my letter).

Mr. Wharton will do good service if, in recording any future observations he will note precisely the local circumstances under which they are made, bearing in mind that such an obstacle as a stack, a barn, a high hedge, or a thick tree might be enough to give the wind an upward throw. I presume he understands that the phenomenon to be explained is that of a bird remaining at rest in mid-air, with wings motionless, not fluttering.

Woodbridge, February 5 HUBERT AIRY

THIS is a very interesting problem, and one which has been very clearly treated by Mr. Hubert Airy, so far as he discusses it.

I think, however, that birds are able to "hover" in other conditions than that he mentions, namely, where the wind is diverted upwards by blowing straight against cliffs or rising ground.

The wind in this country at least is generally of a cyclonic character. Now such wind blows in toward the centre of depression, as has been shown by the Rev. W. Clement Ley, at an average angle of 25 degrees (inward from the tangent to the isobar). If we assume the wind to blow at a distance of 600 miles from such centre at a rate of 20 miles per hour—on an average for one mile in depth—then we have a volume of air converging upon the centre, which must rise into the upper regions there. If we assume, for the sake of obtaining a definite idea of this amount, that the centre of depression covers an area of 70 miles in diameter, say about 4000 square miles, then the air would rise vertically at an average rate of 400 feet per minute over the area. Owing to the friction which the wind experiences in passing over the surface of the earth, however, this upward current could exist at its maximum only at a considerable height. But it is important to observe that there may frequently be a considerable amount of current upwards in the regions where birds "hover," at least in the neighbourhood of a cyclonic vortex. But how much lifting force is necessary to sustain, say a gull, in the air? A gull moves its wings in ordinary flight at from 160 to 200 (double) strokes per minute, and reckoning 12 inches as the greatest vertical depth through which the bird can raise itself by one (double) stroke, we find that it possesses the power of raising itself about 180 vertical feet per minute. This, however, is less than one-half of the rate at which we have found the currents to rise near the centre of a cyclonic depression. From this we may judge it is likely enough that birds "hover," or suspend themselves motionless in the air through the influence of upgoing currents, which are masked to our observation by the fresh winds which accompany them.

A kestrel may, however, support itself largely by its peculiar quivering play of the wings, and I think it must be difficult to determine how much support a bird may contribute by such motion, when at a height where it is difficult to observe it.

I have frequently observed gulls "hovering" upon currents of air which were heaped up by the wind striking obliquely upon a rising coast line, in which case the head is turned at an angle to the general direction of the wind, so as to face the heaped-up and rising currents. Such passing over irregular ground are irregular or gusty, and tax the bird's utmost muscular agility to prevent a sudden lateral turning to leeward, in which case the rapid flight with the currents may be compared to the fall of a stone to the ground. The same upward direction to the atmospheric currents must be imparted by the contracting sides of a converging valley. But when such local forces derive aid from the upward currents peculiar to cyclonic winds, atmospheric conditions favourable to "hovering" must, I think, frequently occur.

On the other hand, I cannot conceive it to be possible for birds (and I do not think that the third chapter of the "Reign of Law," gives any sufficient explanation) to sustain themselves motionless on currents of air which are purely horizontal, for in such case there is nothing to compensate—when the wings are slanted at the necessary angle to prevent falling—the backward horizontal force, and the creature must inevitably be driven backwards. DAVID CUNNINGHAM

Dundee, February 5

ON August 12, 1881, I observed a hawk maintaining an apparently stationary position at a height of about 200 feet above the surface of flat ground. He was *as a matter of course* facing the wind, which blew, if I remember rightly, from the west. For the most part his wings remained motionless, but now and then he fluttered them for a little while. This was over the sensibly level plain which lies between Machrihanish Bay and Campbeltown Loch, at the southern end of the Mull of Cantire, and, curiously enough, on or close to the Duke of Argyll's property. The exact spot was about a mile and a half eastwards from Machrihanish Bay, and about three-quarters of a mile northwards from the southern boundary of the plain. There could not be any "slant upward current," such as Mr. Airy supposes, maintaining him in that position; at any rate, there was no sloping ground near.

I watched this bird for about ten minutes, and he verified in a remarkable manner the views I had held on this subject for many years, namely, that, given a steady wind blowing with a velocity which lies somewhere between certain possibly calculable limits, a hawk can remain for a time apparently motionless above a point; he is, in reality, descending a slightly inclined plane, and requires to recover vertically lost ground by the occasional use of his wings. WILLIAM GALLOWAY

Cardiff, January 30

IN the letters on the above subject that have appeared in some recent numbers of NATURE, the writers lead us to believe that a current of air is *necessary* to enable a bird to "hover" or retain when on wing a motionless position. My observations lead to an opposite conclusion, as I have often seen both hawks and terns remain steadily poised, when there was not a breath of wind. That there was no wind where the birds (*terns*) were, was shown by their heads, when hovering, being turned in different directions, although at only a short distance from each other. Generally, if not always on these occasions, I noticed that the birds spread out their tails in a more or less depressed position, as if to counteract any forward movement likely to be caused by the wing-motion. J. RAE

4, Addison Gardens, February 3

IN reading the letters published in your last issues of NATURE with regard to the hovering of birds, it struck me that a very similar thing can be seen sometimes, among inanimate objects when an imperfect attempt is made to cause "ducks and drakes' with a flat stone. I have commonly noticed that the missile curves sharply upwards and for a moment "hovers" as it were' in mid-air before dropping. In this case and also in the similar one of the motion of the boomerang, the slanting upwards and the apparent hovering do not require, and need not be due to, upward currents, but merely depend upon the force of a horizontal current of air meeting the inherent force of the moving body. It is not unreasonable to suppose a similar simple solution of bird hovering. C. S. MIDDLEMISS

Linnæus Street, Hull, February 3

Is there not an error in the letter of NATURE (p. 312)? The writer there suggests, as it seems to me, that a bird could maintain a position of rest, with respect to the earth, by a suitable slope of the wings against a horizontal wind. Now, as I pointed out in NATURE, vol. xxiii. p. 78, such lifting action on the part of the wind can only take place in the interval between the time when the bird is first launched from the cliff, and the time when it has by friction attained the velocity of the wind. That this interval is not a long one, is shown when balloons or other objects are launched.

[It may be well to notice, that if there were *no* friction there is no lifting power; so that if we object to the above, that "the bird gives such a *very* small friction with the wind," we thereby do away to the same extent with the lifting power; just as a frictionless ship in a constant stream would be unmoved were it sufficiently tapering.]

From the above considerations I have been compelled, since writing my last letter, to ascribe the hovering power of birds—

1. To the "exquisite muscular sense" by which they can take advantage of all upward currents of air, shifting their positions for this purpose. In an elastic fluid as the air, I imagine that the stream-lines, even over the sea, are far from horizontal. I believe the evidence of balloons over the sea goes to show this.

2. There is, to use a common expression, "flying *and* flying;" just as a man can skate without striking out, so can a bird give itself some support by quiet movements of wings and tail.

I may remark that kestrels keep fluttering their wings at short intervals while hovering; they are never still for long. So also terns and gulls, as seen from the fixed point of a cliff, are always moving and shifting in a quiet way, which may disguise both a seeking of upward currents and the quiet sort of "flying." W. LARDEN

Cheltenham College

Science and Theology

CAN you tell me by what right the authorities of Cooper's Hill Engineering College, who are in want of a Professor of Physics, make it a condition that he should "be a Protestant," and should "attend morning chapel and Sunday services with reasonable regularity, showing in this respect a good example to the students?" The institution is one supported by the State, and is surely bound to respect the principles which underlie the State's dealings with religious matters. The President (or whoever is responsible for these preposterous conditions) may have forgotten this fact; but I cannot believe that the present Government will allow an appointment to be made until all "religious" limitations are cancelled from its conditions. As the memorandum stands at present, it appears little short of insulting to scientific men. C.

Intelligence in Animals

MR. GRENFELL's letter in NATURE, vol. xxvii. p. 292, reminded me of a statement in vol. iii. p. 308 of Cook's last voyage, where Capt. King refers to the ordinary sagacity of bears, described in a "thousand stories" which he heard in

Kamtschatka. He gives a single instance, which, he says, "the natives speak of as a well-known fact, and that is, the stratagem they (the bears) have recourse to in order to catch the bareins, which are considerably too swift of foot for them. These animals keep together in large herds, and love to browse at the feet of rocks and precipices. The bear hunts them by scent till he comes in sight, when he advances warily, keeping above them, and concealing himself among the rocks as he makes his approaches, till he gets immediately over them, and nigh enough for his purpose. He then begins to push down with his paws pieces of rock among the herd below. This manœuvre is not followed by any attempt to pursue, until he has maimed one of the flock, upon which a course immediately ensues, that proves successful, or otherwise, according to the hurt the barein receives. I cannot conclude this digression without observing that the Kamtschadales very thankfully acknowledge their obligations to the bears for what little advancement they have hitherto made either in the sciences or polite arts. They confess that they owe to them all their skill in physic and surgery; that by remarking with what herbs these animals rub the wounds they have received, and what they have recourse to when sick and languid, they have become acquainted with most of the simples in use among them, either in the way of internal medicine or external application."

After this we are not surprised when we are told that the Kamtschadales receive instruction from the bears even in the "polite arts," and imitate in their dances the various attitudes and gestures of these animals. It seems that in the *rôles* of master and pupil the proverbial Savoyard and dancing bear would find matters reversed in Kamtschatka.

Millbrook, Tuam, February 3 J. BIRMINGHAM

Electric Railways

PROF. AYRTON speaks as to the advantages obtainable from an electric system of railways. He says:—"The mass of the locomotive adds at least 50 per cent. to the horse-power absolutely necessary to propel the carriages along" (NATURE, vol. xxvii. p. 255). In short, he speaks of the weight of the ordinary locomotive as superfluous, and considers that "a far larger number of passengers may travel at a greater speed and with less fear of danger than at present." Now, speaking practically, it is difficult to conceive of a train of carriages running sixty miles per hour without any massive locomotive in front. It would be easy enough to get up the requisite speed, but the train would certainly leave the road, there being nothing tending to keep the carriages steady, unless they were very heavy. The grip on the rails is directly as the weight of rolling stock, and it is generally found that the light coaches leave the road more readily than the modern heavy carriages. Of course the cant of the rails must not be neglected. I wish that Prof. Ayrton would favour NATURE with a few remarks on these points. V.

The Channel Tunnel

WILL you allow me to correct an unfortunate slip of the pen in my article on "The Silver Streak and the Channel Tunnel" in the current number of the *Contemporary Review?* The rate of the progress of the French Channel Tunnel from the little village of Sangatte towards the English shores was, in November last, 18 yards per day and not "per week." At the present time the Beaumont and English boring machine is cutting the 7-foot driftway at the rate of more than 20 metres per day, and has not arrived at the limit of its capacity. W. BOYD DAWKINS

Owens College, Manchester

The Great Comet of 1882

THE comet not having been visible to my naked eye during the last lunation, I was astonished to find last night that (doubtless owing to its increasing altitude, and the clear, dark sky) its tail is still so visible, quite distinctly, though very faint. I saw it best with a pair of field-glasses, aperture 2·05 inches, power 4; with which it reached to ν^2 Canis Majoris, and was therefore $5\frac{1}{2}°$ long; unless part was really a wisp of the Milky Way: undoubtedly the greater part was the comet. Its axis (which was nearer the north than the south edge) was straight for $3\frac{1}{2}°$, and then appeared to curve southwards somewhat. Its south edge was straight, but its north edge, which was more definite, was convex. Its width was nearly 2°. I could not detect any of the definite features which were so remarkable formerly.

The tail was nearly as long with the naked eye. Its head and two neighbouring stars were plainly visible to the naked eye as one star. One of these stars (Lalande 12,056) was decidedly brighter than the comet's head, which would be about of the 7th mag.

With a $4\frac{1}{4}$-inch refractor the head continues elongated. With a power of 20, its major axis (which was in the direction of the tail) was 16′ long, and its minor axis 11′. With a power of 38 it was 13′ by $8\frac{1}{2}$′. THOS. WM. BACKHOUSE

Sunderland, January 31

Meteor of November 17

IT is perhaps rather late to revert to the auroral cloud of November 17, but I am away from home, and have only now gained the requisite information. The path which I ventured to assign for it in your issue of November 30, from a digest of the printed reports, as compared with my own observations at Clevedon, proves to have been substantially correct. The cloud passed in the zenith at Brussels, as witnessed by M. Montigny, an eminent Belgian savant; and at Laon it was seen to the northward, as it were, gliding round the upper edge of the great main arch of the aurora. The actual elevation above the surface of the earth may therefore, without much risk of error, be considered as between forty and forty-five miles.

Montreux, February 3 STEPHEN H. SAXBY

The Sea Serpent

LIKE your correspondent, Mr. Sidebotham (in NATURE, vol. xxvii. p. 315), I have frequently seen a shoal of porpoises in Llandudno Bay, as well as in other places, and on the occasion referred to by Mr. Mott, in NATURE, vol. xxvii. p. 293, the idea of porpoises was at first started but immediately abandoned. I will venture to suggest that no one has seen a shoal of these creatures travel at the rate of from twenty-five to thirty miles an hour. I have seen whales in the ocean, and large flocks of sea-birds, such as those of the eider duck, skimming its surface; but the strange appearance seen at Llandudno on September 3 was not to be accounted for by porpoises, whales, birds, or breakers, an opinion which was shared by all present.

WILLIAM BARFOOT

Welford Place, Leicester, February 2

IN the summer of 1881 I was staying for some weeks at Veulettes, on the coast of Normandy. While there, on several occasions, several members of my party, as well as myself, saw, at a distance of three or four miles out at sea, what had the appearance of a huge serpent. Its length was many times that of the largest steamer that ever passed, and its velocity equally exceeded that of the swiftest. What seemed its head was lifted and lowered, and sometimes appeared to show signs of an open mouth. The general appearance of the monster was almost exactly similar to that of the figure in your correspondent's letter published on the 25th ult. Not the slightest appearance of discontinuity in its structure could be perceived by the eye, although it seemed incredible that any muscular mechanism could really drive such an enormous mass through the water with such a prodigious velocity. I carefully watched all that any of us caught sight of, and one day, just as one of these serpent forms was nearly opposite our hotel, it instantaneously turned through a right angle, but instead of going forward in the new direction of its length, proceeded with the same velocity broadside forward. With the same movement it resolved itself into a flock of birds.

We often saw the sea-serpent again without this resolution being effected, and, knowing what it was, could with difficulty still perceive that it was not a continuous body; thus having a new illustration of Herschel's remark, that it is easier to see what has been once discovered than to discover what is unknown. Possibly this experience may afford the solution of your correspondent's difficulty. W. STEADMAN ALDIS

College of Physical Science, Newcastle-upon-Tyne, Feb. 3

Natural Enemies of Butterflies

IT would be very interesting to ascertain what testimony can be brought forward to show that the Rhopalocera are commonly the prey of insect-eating birds. The return of a gentleman who has been collecting butterflies and studying their transformations for the last five years in Brazil, and who by my request has given especial attention to the matter, is the immediate occasion of my inquiry. Protective mimicry is a fact too well established to admit of its supporters feeling the question a delicate one. Admission into your paper will speedily settle the question.

Liverpool, Eebruary 2 HENRY H. HIGGINS

ON THE GRADUATION OF GALVANOMETERS FOR THE MEASUREMENT OF CURRENTS AND POTENTIALS IN ABSOLUTE MEASURE[1]

IV.

WE shall now consider, very briefly, the graduation of instruments for measuring volts and amperes in practical work, and we shall take as our example Sir William Thomson's graded galvanometers. The graduation of these instruments is effected by a comparison of their indications with those of a standard galvanometer such as that described above. We shall consider first the graduation of a potential galvanometer, or galvanometer the resistance of which is so high, that the attachment of its terminals to two points in a conductor carrying a current does not perceptibly change the difference of potentials formerly existing between these points. Of course any galvanometer which measures currents also measures potentials, for, if its resistance is known, the difference of potentials between its terminals can be calculated from Ohm's law; but the convenience of a galvanometer specially made with a high resistance coil is that the difference of potentials, thus calculated as existing between the two points at which its terminals are applied while they are in contact, may be taken as the actual difference of potentials which exists between those two points when nothing but the ordinary conductor connects them. For, let V be this actual difference of potentials in volts, let r ohms be the resistance of the conductor, and R ohms the resistance of the galvanometer. Then by the application of R, V is diminished in the ratio of R to $R + r$, and therefore the difference of potentials between the ends of the coil is now $V\frac{R}{R+r}$. Hence by Ohm's law we have for the current through the galvanometer the value $\frac{V}{R}\frac{R}{R+r}$, or $\frac{V}{R(1+\frac{r}{R})}$. If r be only a small fraction of R, $\frac{r}{R}$ is inappreciable, and the difference of potentials calculated from the equation $C = \frac{V}{R}$ will be nearly enough the true value.

The instrument to be graduated is first tested as to the adjustment of its coil, needle, &c. The standard galvanometer and it are then properly set up with their needles pointing to zero, in positions near which there is no iron, and at which the values of H have been determined. The high resistance coil of the standard galvanometer and the coil of the potential instrument are joined in series with a constant battery of as many Daniell's cells as gives a deflection of about 45° on the standard galvanometer, and the magnetometer is adjusted with its index at zero, in such a position on its platform that a deflection of its needle also of nearly 45° is produced. The current actually flowing in the circuit is calculated by equation (11) or (12) from the reading obtained on the standard, and reduced to amperes by multiplying the result by 10. The difference of potentials between the two ends of the coil of the potential galvanometer is found in volts by multiplying the number of amperes thus found by the resistance of the coil in ohms. We can then obtain, by an obvious calculation, the number of divisions of deflection which corresponds to one volt between the two ends of the coil, and thence from the value of H the number of divisions which would correspond to one volt if the intensity of the field were one c.g.s. unit. This would be the number which would be marked at that position on the platform of the instrument; but, except for the position of the magnetometer nearest to the coil, positions the corresponding numbers of which are multiples and submultiples of 2 are alone marked. The numbers corresponding to the two of these positions adjacent on the two sides of the position of the magnetometer in our experiment, may be readily found by keeping the same difference of potential on the coil, and moving the magnetometer nearer to or further from the coil until the deflection is increased or diminished in the proper ratio. For example, let the deflection be 40 divisions for 20 volts, and let the value of H at the instrument which is being graduated be ·17. The number of divisions of deflection which would correspond to one volt for that position, if the field were of unit intensity, would be $\frac{40}{20} \times \cdot 17 = \cdot 34$. Hence the marked positions nearest to this in the two sides of it, are to be those for which the corresponding numbers are $\frac{1}{2}$ and $\frac{1}{4}$. Therefore the magnetometer must be moved further from the coil for the latter until the deflection produced by 20 volts becomes 29·4. This is the position at which the number $\frac{1}{4}$ is to be marked. To find the position at which $\frac{1}{2}$ should be marked a smaller difference of potentials must be used, as the deflection with the same battery as before would be beyond the limits of the scale. Suppose that when its number of cells is diminished to one half; we get a deflection for our first position of 20. While the potential difference in the coil remains constant, the magnetometer is pushed in until the deflection again becomes 29·4. At this position the number $\frac{1}{2}$ is to be marked. From this it is easy to see how the position for the number 1 can be found, and in the same way those for the other numbers of the series, 2, 4, &c. The number corresponding to the position of the magnetometer nearest to the coil, although not one of the terms of this series, is determined in the same way, and marked at that position on the platform. This is the method adopted in practice in the graduation of these instruments.

Another method sometimes convenient is as follows. The standard instrument, a few good Daniell's cells, and a resistance which gives a deflection of about 45° on the standard are joined in series, and the galvanometer to be graduated is applied at two points in the circuit which include between them such a portion of the resistance as gives a deflection of about the same amount. Let R ohms be the portion of the resistance included between the terminals of the galvanometer, and let G ohms be the resistance of the galvanometer coil. Let the current calculated from the deflection on the standard be C amperes, then if V be the potential difference in volts between the terminals of the potential instrument, we have by Ohm's law—

$$C = \frac{V}{R'},$$

where R' is the resistance equivalent to the divided circuit of R and G. But $R' = \frac{RG}{R+G}$, and therefore

$$C = V\frac{R+G}{RG}.$$

Hence,

$$V = C\frac{RG}{R+G}.$$

This last equation gives the number of volts indicated by the deflection on the potential instrument, for the position at which its magnetometer is placed; and from this in precisely the same manner as described above, the series of positions of the magnetometer on its platform are determined and numbered.

[1] Continued from p. 321.

For verifying the accuracy of the graduation of the potential instruments when performed by either of these methods, a standard Daniell's cell of the form proposed by Sir William Thomson at the Southampton meeting of the British Association is used. It is represented in the annexed cut (Fig. 4). It consists of a zinc plate at the bottom of the vessel resting in a stratum of saturated zinc sulphate, on which has been poured, so gently as to give a clear surface of separation, a stratum of half saturated sulphate of copper solution, in which is immersed a horizontal plate of copper. The copper-sulphate solution is introduced by means of the glass tube shown in the diagram dipping down into the liquid, and terminating in a fine point, which is bent into a horizontal direction so as to deliver the liquid with as little disturbance as possible. This tube is connected by a piece of indiarubber tubing with a funnel, by the raising or lowering of which the sulphate of copper can be run into or run out of the cell. By this means the sulphate of copper is run in when the cell is to be used, and at once removed when the cell is no longer wanted.

The electro-motive force of this cell has been determined very carefully and found, according to Lord Rayleigh's latest determination of the ohm, to be 1·07 volt at ordinary temperatures. The direct application of this cell to the galvanometer gives at once a check on the graduation. As the resistance of the galvanometer is always over 6,000 ohms, there is practically no polarization.

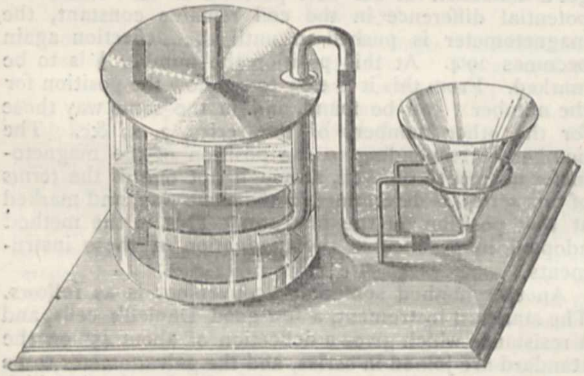


FIG. 4.

The method adopted for the graduation of the current galvanometer is precisely the same as that first described for the potential instrument. The standard galvanometer, of which in this case the low resistance coil is used, and the current galvanometer to be graduated are joined in series with a battery, which with some resistance in circuit is sufficient to give a deflection in each of about 45°, when the magnetometer of the current instrument is at a convenient position on its platform. The current flowing in amperes is given by the standard, and this, of course, is the number of amperes which is indicated by the deflection of the current instrument. By an obvious calculation from the value of H at the current instrument, precisely similar to that above described, the number of divisions of deflection corresponding to a current of one ampere for a field of unit strength is found, and from this the series of positions on the platform and their numbers are found.

The value of the field intensity given at the needles of the magnetometer when in position has generally been determined in the following manner. A battery of about 30 of Sir William Thomson's Tray Daniell's is joined in series with a resistance of about 7,000 ohms. The electrodes of a potential galvanometer, on which the magnetometer is placed without its magnet, are attached at two such points in this resistance that the deflection of the needle produced is from 30 to 40 division on the scale. The current through the galvanometer is now stopped and the magnet placed in position, and the index brought to zero by turning the magnet by means of its screw. The electrodes are now placed so as to include a resistance which makes the deflection nearly what it was in the former case. Let E be the electromotive force of the battery, I the intensity of the horizontal component of the field produced at the needles by the magnet; R_1 R_2 the amount of this resistance included between the electrodes of the galvanometer in the first and second cases respectively; V_1 and V_2 the potential difference in volts on the instrument in the same two cases; D_1 and D_2 the corresponding deflections, and G the resistance of the galvanometer. We have by Ohm's law

$$V_1 = \frac{E R_1 G}{(B + R - R_1)(R_1 + G) + R_1 G} = m H D_1$$

and

$$V_2 = \frac{E R_2 G}{(B + R - R_2)(R_2 + G) + R_2 G} = m I D_2$$

where m is a constant. Therefore we have

$$I = H \frac{D_1 R_2 \{(B + R - R_1)(R_1 + G) + R_1 G\}}{D_2 R_1 \{(B + R - R_2)(R_2 + G) + R_2 G\}}$$

If the resistance B of the battery be small in comparison with G, or if the galvanometer is sensitive enough to allow $\frac{B}{G}$ to be made sufficiently small by resistance added to G, B may be neglected; and it is generally possible, by properly choosing R, R_1, R_2, to simplify very much this formula. The number I thus found, diminished by H, is the number of c.g.s. units which measures the horizontal intensity of the magnetic field produced at the needle by the action of the magnet alone. The value of $I - H$ is the number painted on the magnet, and is generally about 9 or 10.

$I - H$ may be determined by means of a current galvanometer very easily by keeping a constant current flowing through the instrument, and using without the magnet one of the less sensitive positions of the magnetometer, and with the magnet one of the more sensitive positions. If D_1 and D_2 be the deflections and n_1 n_2 the number of divisions of deflections corresponding to one ampere at the two respective positions, the value of I is at once found from the obvious equation

$$\frac{D_1}{n_1 H} = \frac{D_2}{n_2 I}, \text{ or, } I = \frac{n_1 D_2}{n_2 D_1} H.$$

When either instrument has been graduated for a field of intensity equal to 1 c.g.s. unit, and the intensity of the field given by the magnet at the needles has been determined, the graduation of the instrument is complete. In the practical use of the instrument with the magnet in position, the number of volts, or the number of amperes (according as the instrument used is a potential or a current galvanometer) corresponding to a deflection of any number of divisions is found by the following rule:—

Multiply the number of divisions in the deflection by the number on the magnet increased by the horizontal intensity of the earth's field,[1] *and divide by the number at the division on the platform scale exactly under the front of the magnetometer.*

When the magnet is not used the rule is the same as the above, except that the divisor to be used is the value of H for the place of the galvanometer.

For convenience in the ordinary use of either instrument a position of the magnetometer on its platform, which may not be one of the series described above, is determined at which the deflection with the magnet in position, for one volt or one ampere, is one or some other convenient number of divisions. For this position lines

[1] The mean value of H for Great Britain may, *when the magnet is used*, be taken with sufficient accuracy as ·17 c.g.s.

are drawn on the sides of the platform so as to prolong the white lines on the sides of the magnetometer. By this means currents in amperes or potentials in volts can be at once read off without any calculation.

The graduation of the current galvanometer may also be performed by means of electrolysis. The electro-chemical equivalents of a large number of the metals have been determined, and it is only necessary therefore, in order to graduate the instrument, to join it in series with a proper electrolytic cell and a constant battery, and to compare the amount of metal deposited on the negative plate of the cell with the total quantity of electricity which flows through the circuit in a certain time. A convenient cell may be made with two plates of copper, each about 50 square cms. in area, held parallel to one another about 2 cms. apart, and immersed in a nearly neutral solution of copper-sulphate in a glass beaker. A current of one ampere through such a cell gives a very good result. This current will deposit about 1·2 grammes of copper per hour, which, when light plates are used, can be very accurately weighed. The plates should be carefully cleaned, dried, and weighed before being immersed in the liquid, and care must be taken not to send the current through the cell at all until it is made to flow continuously for the experiment. The instant the current through the cell is completed should be noted, and readings of the current galvanometer taken at equal short intervals during the time allowed for the experiment. The average of these readings is to be taken as the average reading of the galvanometer. When the experiment has been completed the plates are to be taken out and very carefully washed in clean water and dried before being weighed. It is generally better to calculate the quantity of electricity from the gain of the negative plate than from the loss of the positive. The electro-chemical equivalent of copper has been recently determined afresh with great care in the Physical Laboratory of the University of Glasgow by Mr. Thomas Gray, and as the result of his experiments ·000331 of a gramme of copper is deposited by the passage of one coulomb of electricity. Dividing the gain of weight of the negative plate by this number, we obtain the total number of coulombs which have flowed through the galvanometer during the experiment. This divided by the time in seconds gives the average current in amperes; from which the number corresponding to the position of the magnetometer on the platform can be determined, and the graduation completed in the manner described above.

Errata in Part II. of this Article—P. 106, line 2 from top, for $2\pi nCA$ read nCA; line 5, for $CD(=x)$ read $CD(=y)$; line 6, for $DE(=y)$ read $DE(=x)$.

ANDREW GRAY

NORWEGIAN GEODETICAL OPERATIONS[1]

THIS publication of the Norwegian Committee of the Association for the Measurement of Degrees in Europe is a report of the observations made at two tidal stations in Norway—Oscarsborg and Drontheim. The report opens with a summary of the previous tidal operations carried out in Norway. From June 8 to 28, 1835, a series of observations were made at a large number of stations at the request of the English Admiralty. These observations, together with those from numerous other stations in Europe, along the North Sea, and Atlantic coasts, were reduced and compared by the Rev. Dr. Whewell, and were published by him in the *Philosophical Transactions* of 1836.

The next tidal operations recorded were undertaken in 1839, to ascertain whether, as supposed, the Norwegian coast is slowly rising. With this object, marks were cut in the rock at twenty-six points along the coast, and the date was inscribed in each case. On the eastern coast, where there is little or no tide, only one mark was cut, at the level of the water; but along the western and northern coasts two marks were made, one at high water, and the other at low water. The report gives a detailed description of the position of these marks. In 1865 observations were made to ascertain if any alteration had taken place in the relative positions of these marks and of the sea, and it was found that on an average the land was rising at the rate of 3″ in 26 years. It was, however, seen that such determinations were very inadequate, since the mean level of the sea had not been taken into account, and the marks were not connected by lines of levelling. The whole question was accordingly placed before a Committee of the University. This Committee, however, came to no conclusion, principally on the ground of the expense of the necessary levelling operations. It was then pointed out by Prof. Fearnley, the chairman of the Committee of the Association for the Measurement of Degrees in Europe, that the resolutions of the Association at the General Assembly in 1864, at Berlin, had given an increased importance to the determination of the mean tide level. Nevertheless, it was not until 1876 that any steps were taken to establish a series of tidal stations provided with self-registering apparatus, as enjoined by the Association; six stations have now been established, and two more are to be formed.

Previously however, namely, in 1872, two stations had been established, one at Oscarsborg, in the fortified island of Kaholmen, situated in the Christiana fiord, in connection with submarine mining, and where observations have been recorded from 1872 to 1879; the other at Drontheim in connection with the harbour works, the observations at this station have extended from 1872 to 1878. These two sets of observations form, as already mentioned, the subject of the present report.

At both stations self-registering apparatus of simple designs were used. At Oscarsborg the rise and fall of the tide was marked on a *plane* sheet of paper attached to a frame moving horizontally. The motion was imparted to this frame by a weight, which, in order that the motion might be uniform, was connected to a clock. The float was inclosed in a tube, so as to annul the disturbing action of the waves. At Drontheim the paper was attached to a drum rotating uniformly by means of clock-work. The apparatus was placed at the end of a pier, and the scribing pencil was connected by a system of rods to a bridge, the other end of which was supported by a pontoon. In this manner the action of the waves was eliminated. The mean tide level was obtained at these two stations by taking the arithmetic mean of the heights of the tide recorded on the diagrams for each hour, and not by the more accurate method based on the areas described. But since these observations extended over several years, the result is no doubt practically the same; moreover, neither apparatus was provided with any means of obtaining the areas automatically, and to calculate them would have involved an enormous amount of labour.

The observations at both stations are arranged in a series of tables.[1] Table I. gives the heights of the tide at each hour, commencing at noon, for every day during one month.[2] The arithmetic mean of the heights of the tide at the *same* hour each day during the month, are also given for every hour of the day; the moon's influence does not appear in these means, they therefore show the influence of the sun. These means, for every month during which the observations lasted, are collected together in Table IV., and the mean of these means is also given. Table II. gives the height of high and low

[1] Publication of the Norwegian Committee of the Association for the Measurement of Degrees in Europe, Part I. (Christiana, 1882.)

[1] The corresponding tables in each set of observations are denoted by the same number.

[2] This table was not extended further, in order to save space in the Report.

water, the time of their occurrence, and the range of the tide for every day of the same month as before. Table III. is similar to Table I., but the hours are counted each day from the upper culmination of the moon, instead of from noon. By thus arranging the table, the sun's influence is eliminated in the means for each hour, and the moon's influence on the tide is thus made apparent. Table V. corresponds to Table IV. The remaining tables, VI. to XII., give information as regards the interval of time between the moon's upper or lower culmination and high water, and similarly for low water; also the height of the highest and lowest high and low water recorded each month, specifying the direction of the wind and the height of the barometer; and lastly, the greatest and least range of the tide during each month.

The report concludes with a comparison of the semi-menstrual inequality as calculated by Whewell's formulæ, and the actual observed inequalities. The agreement is very close.

There is no discussion in the report of the results obtained, this being reserved for future publications, when the observations at the other stations are available.

The report is accompanied by five plates, showing the registering apparatus, and giving specimens of the diagrams.

SCIENTIFIC HERESIES IN CHINA

THE belief of the old writer who explained the disappearance of the swallows in autumn, by the assumption that they all rolled themselves together into a mass, beak to beak and wing to wing, and plunged "fluminibus lacubusque," there to remain until the return of spring, is but an instance of the thousand and one theories which have from all time been held by unscientific observers on the subject of the annual appearance and disappearance of migrating birds. It is not so very long ago that even among ourselves the question of the migration of sand martens was a moot point; and it need not be a matter of surprise, therefore, that the Chinese, though keen observers of nature, should be guilty of holding heretical hypotheses to account for the presence in summer and the absence in winter of birds of passage, as well as for other processes of nature which are enacted before them. Like most common fallacies, those current in China on these subjects are derived from ancient authorities, but, unfortunately, in the case of the Chinese, whose respect for everything that is old is supreme, this antiquity only entails upon them the more unquestioning faith. They are, therefore, perfectly content to believe that the disappearance of quails in autumn is sufficiently accounted for by the assumption that at that time of the year they are transformed into moles, and that in spring they succeed in reappearing again in beaks and feathers. The explanation of this fallacy is simple enough. The ploughman who in the spring and summer has seen the quails flitting among the mole-hills, finds that when, the birds having disappeared, he ploughs over the same land in winter, the moles, which he has not before seen, are the sole occupants of the ground.

Another generally accepted belief is based on what Max Müller calls a disease of language. At the opening of spring, hawks are said to become pigeons, and at midsummer to be reconverted to their original shapes. Now it happens that *Kiu*, the Chinese name for a pigeon, forms the second syllable of the word for a crested hawk (*Shwang-kiu*), and it would appear that by a corruption of terms and a confusion of ideas the first syllable has been dropped and the last has been allowed to stand in its literal and isolated meaning. Thus the original assertion that during the breeding season hawks become crested has been perverted into a meaningless and self-condemnatory myth. Chinese writers on natural history lay stress on the fact that during the spring, when "the rearing instinct in birds becomes excessive, birds of prey become excited," and when excited or angry, hawks, as is well known, erect the feathers on the head, giving the appearance of a crest.

Much in the same way has arisen the legend that in late autumn certain small birds go into the sea and become crustaceæ. In this case the error depends on the word *wei*, which is here translated "become," but which also means "for," and which, when so read, converts an absurdity into the record of a fact concerning the birds probably referred to, namely, sandpipers. These birds, we know, "frequent sandy sea-shores, some of them congregating in numerous flocks in autumn and winter, and seek their food by probing the sand with their bills, and by catching small crustaceans in pools or within the margin of the sea itself."[1] The same mistake, which is, however, complicated by a further misunderstanding, makes it incumbent on Chinamen to believe that in winter pheasants go into the lakes and become clams. The word here translated "clams" means also "sweet flags and water rushes," and in search of these hungry pheasants might very probably be tempted to seek the margins of swamps and lakes. A curious and unaccountable superstition was anciently and is still connected with this habit of Chinese pheasants. We have it on the authority of one of the Classics that "if within ten days from the beginning of winter pheasants do not go to the great waters, lascivious women will multiply in the country."

Otters and polecats, again, are the subjects of a more sentimental belief. They are said to be in the habit of offering up, the one fish, and the other animals, in sacrifice. This strange myth is accentuated in the "Imperial Encyclopædia," published by order of the Emperor K'ang-he (1661-1722), by an illustration attached to the chapter on otters, in which one of those animals is represented as squatting down on the bank of a river with his two forepaws on a newly-captured trout, and with a most devout expression on his upturned face, which is directed towards the moon. The explanation of this legend is not far to seek.

The habit common to both otters and polecats of destroying many more creatures than they are able to devour, and of leaving their victims apparently untouched after having satisfied their appetites with the flakes at the back of the fishes' necks, and with the blood of the animals, suggests to careless and superstitious observers the semblance of propitiatory sacrifices offered up to the patron saints of vermin.

Many other generally accepted myths might be quoted, which are but the perverted representations of facts. But if we descend to a lower level, to the vulgar superstitions of the masses, we find ourselves in a region where—

> "Wisdom and Wit are little seen,
> But Folly at full length."

A resemblance in outward form, or even in disposition, is enough to give rise to a belief that the animals are interchangeable. Thus eels are said at times to be transformed into serpents, mice into bats, and sharks into tigers, and *vice versâ*. By a curious connection of ideas, between kings and whales, also comets, those stars so abhorred by rulers, are considered to be as destructive to the lives of the monarchs of the deep as of the sovereigns of the soil.

NOTES OF TRAVEL IN SARDINIA

WHILE Sicily possesses classical associations and remains of the highest interest, together with physical features more or less dependent upon the presence of the most famous volcano in the world; and while Lipari and the associated islands are remarkable for their evidences of past and present volcanic action,

[1] *Chambers' Encyclopædia.*

Sardinia can lay claim to neither the one interest nor the other, to any marked degree. Neither can we compare it with Iceland, or with Majorca, and perhaps the only special interest which belongs to it is the occurrence of large numbers of *nuraghi*—conical stone mounds of prehistoric construction, hollow within, and probably designed as tombs by the earliest inhabitants of the island. These are scattered over the island in large numbers, particularly near Torralba.

In Roman times Sardinia never rose to much importance, hence the relics of that period are but few. The most important is an amphitheatre near Cagliari hewn out of the rock, the major axis of which is 153 feet in length, and the minor axis 98 feet. It is now in a very dilapidated condition, far more so indeed than that of Puzzuoli. There are also a few Roman tombs. The most remarkable is in a suburb of Cagliari called Santa Tenera, and it is known as the *Grutta dessa Pibera*, that is the Grotto of the Viper, from the serpents which are sculptured over the entrance. It was the tomb of Attilia Pamphilla, a noble Roman lady. On the walls there are some interesting inscriptions, which have been published by General La Marmora and by Muratori.

The few travellers who visit Sardinia nowadays are tempted rather by prospects of sport than by anything else. Moufflons still exist among the Gennargentu Mountains, also wild boar, and smaller game, but the amount of sport afforded by the island has been exaggerated, and the sportsman will commonly prefer to go to the north of Norway or to Iceland to running the risk of catching malarious fever in Sardinia.

Malaria has always been very prevalent in the island. There is a large extent of marsh land, and in the autumn a great deal of decomposing vegetable matter. We were glad to notice that some of the Englishmen who have recently acquired land in the island have not only commenced draining operations, but have also planted numbers of Eucalyptus trees, the effect of both operations being undoubtedly to diminish malaria. On the other hand, many of the native landowners are converting their timber into charcoal, for which they can obtain about fifty francs a ton in France and elsewhere. Some thousands of tons are annually shipped, and unfortunately new trees are not planted in place of the old ones. If this wholesale destruction of forests continues, there can be no doubt that the climate of the country will eventually be seriously affected. The exporters do not in the least realise that they are shipping *vis viva* in a very condensed form from their shores, and at the same time diminishing the rainfall.

The chief wealth of Sardinia lies in her mines of argentiferous galena, and of calamine. As much as 120 ounces per ton of silver have been extracted from some of the lead ores. The principal mines are those of Monte Poni, near Iglesias, in the south-west of the island, and of Monte Vecchio, in the west centre. At Monte Poni we noticed that the newest forms of Belgian and German machinery for crushing and washing the ores were in use. At the present time, the operations are very much impeded by the flow of water into the principal shaft, which will probably be to a great extent obviated, by boring a tunnel through the side of the mountain in which the shaft is sunk.

A railway constructed, and to a great extent owned by an English company, now connects the two capital cities of the island—Cagliari and Sassari—a distance of 260 kilometres, with branches to Iglesias, in the south-west, and to Terranova in the north-east, and the line is continued from Sassari for 12½ miles to Portotorres, its port, a miserable and fever-stricken village. Fifty years ago, there were scarcely any roads at all in Sardinia. The Roman roads had become obliterated, and no attempt had been made to construct them afresh.

The railway is well constructed, but the trains are extremely slow, and do not average more than seventeen miles an hour. Between Macomer and Chilirani there are many cuttings and some very steep gradients. The railway connecting the two capitals—Cagliari and Sassari—has only recently been completed. Sassari, a town of 33,000 inhabitants, is nearly as large as Cagliari, and in some respects preferable to it. It stands upon a hill 650 feet above the sea. It has a clean, bright appearance, but in reality is very badly drained and extremely unhealthy. So recently as 1855 the cholera carried off nearly one-third of the population in less than three weeks, at the rate of more than 500 a day.

In Torralba there are a number of *nuraghi*, and in the neighbourhood several extinct volcanoes, the most important of which is Keremule. Nearly midway between Mores and Torralba we saw exposed, in a recent railway cutting, a fine mass of columnar basalt overlying chalk. There is a good deal of pale green, pale pink, and grey trachite in the neighbourhood. The only geological map of the island which now exists is in General La Marmora's fine monograph published in Paris and Turin between 1839 and 1860, and entitled *Voyage en Sardaigne*.

G. F. RODWELL

MATHEMATICS IN SCANDINAVIA[1]

THE first part of the new mathematical journal has reached us. We have not quite reproduced the title; the words *Zeitschrift herausgegeben von* on one side of the axis of symmetry (let us say) of the page, are matched by the words *Journal rédigé par* on the other side. This is significant of one part of the Editor's plan: the journal, though printed and published in Stockholm, is to have its articles written in what the Editor styles the *principal* languages. It may be that English is one of these languages; there is not, however, in the preface, anything definite to relieve our doubts. The prospectus (unintentionally, we hope) is somewhat more informatory. In the language of our "lucid" neighbours it says: "In Germany, in France, in Italy, in Scandinavia, everywhere in fact, where science is held in honour (other side of the line of symmetry—'*überall wo mathematisches Leben herrscht*'), the idea of starting the journal was received with the most lively sympathy." Apparently in regard to the English language and English science, the less said the better. We, for our part, say nothing.

In outward appearance the new journal closely resembles Crelle's. The paper is equally good, the margin equally broad, and the size of page and the number of pages in a part substantially the same in the two serials. Neither is quite so handsome as a third member of the same family, the now five-year old *American Journal of Mathematics*; but then we must not forget the ratio of five dollars to twelve marks.

The list of the editorial staff supporting M. Mittag-Leffler contains many distinguished names. There are five Swedish mathematicians, four Norwegians, three Danish, and one from Finland; and scarcely one of these but is well known far beyond his native country.

The contents of the first part are all that could be expected from such a brotherhood, headed by such a chief. The first paper is by Prof. Poincaré, of Paris, its subject being the *Théorie des groupes fuchsiens*. It extends to 62 pp., and is altogether worthy of its place of honour. One does not know which to admire most—the author's grasp of his subject, or the clearness and simplicity of his exposition. Following this, comes a contribution of 14 pp. by Prof. Malmsten, of Upsala, "Zur Theorie der Leibrenten;" then there is a paper of 16 pp. on "Eine Annäherungsmethode im Probleme der drei Körper," by M. Gyldén, the head of the Stockholm Observatory; and lastly, to complete the 96 pages, there is

[1] Acta Mathematica: Zeitschrift herausgegeben, von G. Mittag-Leffler. (Stockholm, 1882.)

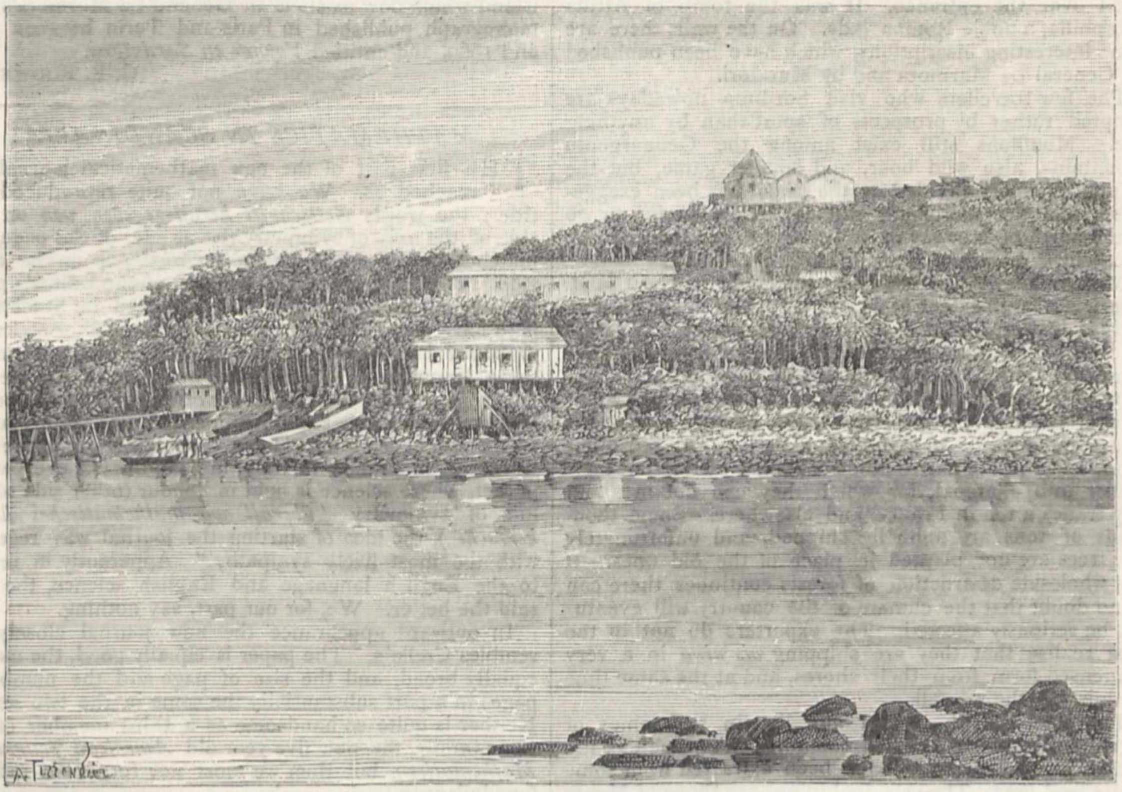
a short communication entitled "Das Problem der Configurationen," by Prof. Reye, of Strassburg. The Editor may be most heartily congratulated on the start he has made: taking everything into account, we have little doubt but that his efforts will be crowned with abundant success.

The most serious difficulty about such an undertaking is that of finance. The *American Journal* began its career with the Johns Hopkins trustees at its back: we suppose, however, that by this time it walks alone. In the present instance, the mainstay is the enlightened King Oscar the Second. Long may he live! The journal is rightly dedicated to him, the dedication being made appropriately in one of the second-rank languages, which it is cheering for us to see, have sometimes their uses.

M. D.

THE FRENCH MISSION TO CAPE HORN

THE members of the French Magnetic and Meteorological Expedition to Cape Horn have taken up their quarters at Orange Bay, and have already begun work. The accompanying illustration, reproduced from *La Nature*, after a photograph transmitted to the Paris Academy of Sciences, will give an idea of the aspect of the station occupied by the expedition. On the summit of the hill are the astronomical cabins, beside which are placed a pluviometer and an actinometer. The large house in the middle distance forms the officers' quarters, while the lower building is for the sailors. Along the shore are other structures partly shown in the illustration, a stockade for the tidal register, and an isolated tent for absolute determinations.



Station of the French Mission to Cape Horn.

The mission arrived at Orange Bay, Terra del Fuego, on September 6 last. They found the country marshy, and were compelled to select a wooded spot in order to obtain firm ground. No time was lost in erecting inclosings and installing the various instruments; and on September 26, the meteorological and magnetical observations were begun. Since the arrival of the party the temperature at Orange Bay has been very mild; the thermometer has never been below 0° C., and several times it has been as high as 16°. The air is very moist, and there has been plentiful rain almost every day, though not lasting long. Squalls have been rare. The magnetic observations will be made partly by instruments which will be read directly,—absolute determinations of declination, inclination, horizontal force, &c., and partly by means of regulating apparatus, which, so far, have worked very satisfactorily, and have given indications agreeing with those obtained from direct-reading magnetometers. The other duties of the expedition consist in astronomical and meteorological observations.

The expedition has been well received by the natives, one of whom speaks and reads English fluently. Indeed, twenty miles off, in Beagle Channel, is an English mission station, which is reported to be very prosperous. On the whole, the French expedition has been very successful; it may be regarded as one of the International Polar Observing Stations.

HEATING BY ACETATE OF SODA

M. A. ANCELIN, Civil Engineer, describes in *La Nature* a method he has devised of heating for domestic purposes, travelling, &c., by means of acetate of soda. His object has been to devise a method that will possess all the advantages of heating by means of hot water, without any of its inconveniences. For this purpose he sought for a vehicle having a great latent heat of fusion, and after several preliminary experiments, he, in September, 1878, took out a patent for heating carriages, &c., by means of the latent heat stored in solid substances pre-

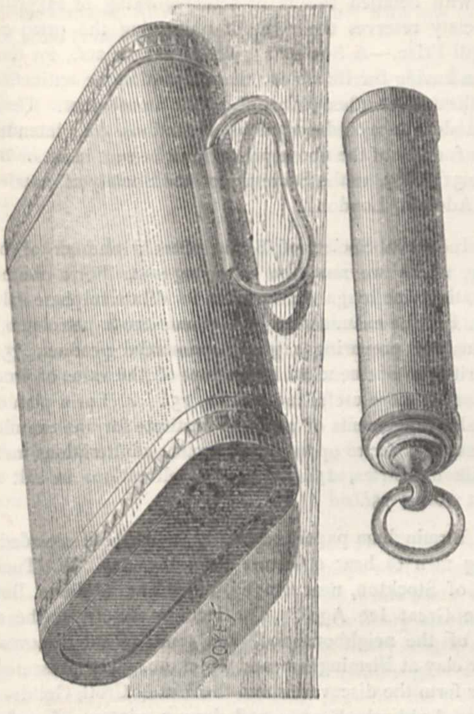


FIG. 1.—Warming-pans with acetate of soda for domestic use; the large form is for apartments or beds, the smaller for a lady's muff.

viously liquefied by heat. In the course of his experiments, M. Ancelin's attention was called by M. Camille Vincent to the acetate of soda, the very slow cooling of which

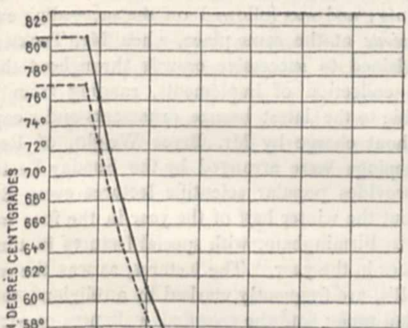


FIG. 2.—Curves of cooling of warming-pans with water.

during manufacture had struck him. M. Ancelin then experimented with this substance, and obtained satisfactory results. The duration of the heat in a warming-pan with acetate of soda he finds to be four times that of a warming-pan with hot water in spite of the great calorific capacity of water. This is due to the enormous quantity of heat which must be applied to the acetate of soda in order to change it from the solid to the liquid state, a heat which it again gives off as it resumes the solid state. As the result of his experiments, M. Ancelin finds that the quantity of useful heat is in fact four times greater in acetate of soda than in water. A railway warming-pan containing 11 litres of water, in passing from 80° C., the mean temperature at which it is put in the carriage, to 40° the temperature below which the heat is no longer perceptible, disengages 440 calories (11×40). The same pan containing about 50 kilogrammes of acetate, in passing from 80° to 40° disengages 1731 calories instead of 440. Practice is in accord with theory, as may be seen from the curves in Figs. 2 and 3. We see how rapid is the decrease in the temperature of the water warming-pan, while for the acetate pan the curve, at first parallel to that of water, suddenly changes at the point

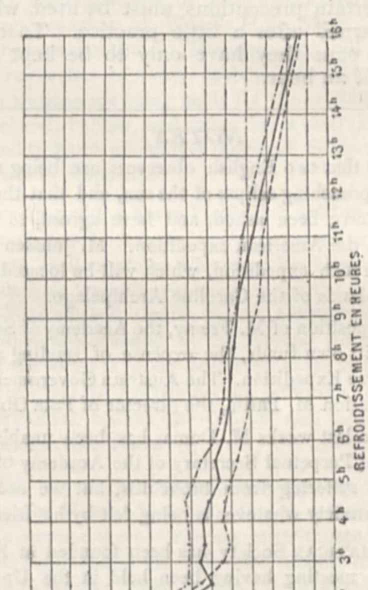


FIG. 3.—Curves of cooling of acetate of soda.

which corresponds to the temperature of crystallisation. The curve then remains almost horizontal, and falls very gently, rendering evident to the eye what takes place inside the pan. We obtain this result at a much less expenditure of heat for the acetate than for water. To raise the pan of water of 11 litres from 10° to 90°, four times, there is required 3520 calories. For the same quantity of acetate only 1987 calories are required, showing a saving of 1500 calories in favour of the acetate. In reality the saving is much greater. In the case of the water-pans raised to 90°, they are only at a maximum of 80° when put in the carriage, and for four heatings we get only 1760 calorics, or 50 per cent. of the heat stored. In the case of the acetate, there are only 256 calories unutilised, or about 12 per cent. of the quantity stored. M. Ancelin claims for his method that it required almost one-half less expenditure of heat than in the case of the usual warming-pans, especially when we consider that the water requires four separate heatings, and the acetate only one. Long journeys can thus be made by rail, say from Paris to Havre, Lyons, Bordeaux, &c., without having to change the warming-pans, a great saving of labour and of annoyance to passengers. Several companies both in France and in other countries now employ M. Ancelin's method of heating; the French Western Railway Company use it in their carriages from Paris to Havre, and also to Dieppe. In England, M. Ancelin states, the London and North Western Company had, last winter, 3000 of his acetate pans in use, and double that number during the present year.

He shows that his system may be applied to domestic purposes as well as on railways. It is certainly preferable to charcoal, which, in France, is a fertile cause of death by asphyxia. Fig. 1 shows a portable apparatus, which may be used in private carriages, and even as a foot-pan in bed, and several other purposes, its heat lasting five hours. The smaller figure shows a form of heater which may be used in a lady's muff or even in the pocket. The openings by which the acetate is introduced are hermetically closed, and the substance does not require renewal except at very long intervals. In filling the receptacle certain precautions must be used, which may be easily learned after a little practice. To renew the heat in the pans they have only to be kept in boiling water for half an hour.

NOTES

WE believe that two English observers are being sent out to record the approaching eclipse of the sun, and that the American Government have been asked, and have agreed, to find places for them with the American expedition. M. Janssen will be the head of the French expedition, which will be located on one of the smallest islands of the Caroline Archipelago.

ON the proposition of M. Fremy, the Academy of Sciences will defray, from its own funds, the expense of sending a naturalist with the Eclipse Expedition. The Austrian Government will send to the same station M. Palisa, the director of Pola Observatory.

FOR the two last weeks M. Dumas has been unable to attend to his duties of Perpetual Secretary of the Academy of Sciences. He has been suffering from bronchitis, but we are happy to state that no anxiety whatever is being felt by his friends.

A MATHEMATICAL Society has been founded at Edinburgh, the initiatory meeting having been held in the University on Friday last. Mr. John S. Mackay, M.A., F.R.S.E., Mathematical Master in the Edinburgh Academy, was chosen the first president, and Dr. Knott, secretary. Professors Tait and Chrystal were elected honorary members.

GENERAL PITT-RIVERS has offered his well-known and invaluable collection, now in the South Kensington Museum, to the University of Oxford, on condition that the University provides a suitable building for it. It is to be hoped, for the sake of the University and in the interests of science, that the authorities will accept the collection on the conditions imposed by the generous donor, though we should deeply regret its removal from London.

WE are not surprised that the London School Board should have hesitated last week to commit itself to the importation at once of technical education into elementary schools. The adoption of Dr. Gladstone's motion, that a committee be appointed to consider how best the Board could help in the matter, seems to us to be the judicious course to follow.

THE following premiums are offered by the Society of Arts for the 129th Session of the Society (1882-83):—Benjamin Shaw Prize.—1. A Society's gold medal, or 20*l*., for the best plan for "obviating or diminishing risk to life in the operations of coal mining." 2. A Society's gold medal, or 20*l*., for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives." The Council of the Society leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise. Howard Prize.—A prize of 100*l*. for the best essay on the Utilisation of Electricity for Motive Power. Preference is to be given to that essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working or experiment. The Society reserves the right of publishing the prize essay. Fothergill Prize.—A Society's gold medal, or 20*l*., for the best invention having for its object the prevention or extinction of fires in theatres or other places of public amusement. Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above prizes, must be sent in on or before October 31, 1883, to the Secretary of the Society of Arts, John Street, Adelphi, London.

THE Industrial Society of Berlin offers a number of prizes, amongst which we note the following:—1. For a method of precipitating zinc by galvanism from its dilute sulphate solution, 50*l*. 2. For the examination of German crude petroleum, with directions for preparing a good commercial product, 75*l*. 3. For a criticism of the usual indications of the value of iron and a proposal of more useful indications, 15*l*. 4. For a plan of the technical arrangements of a public institute for the examination of tissues, in order to oppose the frequent adulterations met with in textile industries, 15*l*. 5. For ameliorations in salt mines and salt works, 75*l*.

THE Birmingham papers report the Town Hall crowded with working men to hear a lecture from the Rev. W. Tuckwell, Rector of Stockton, near Rugby, on "The Midland Boulders and the Great Ice Age.". The lecturer described the erratic blocks of the neighbourhood, and some recent discoveries of boulder clay at Birmingham and Stockton. He presented in a popular form the discoveries and theories of Croll, Geikie, Boyd Dawkins, Lubbock, Evans; and drew a picture of early man and his brute contemporaries as revealed by the bones and implements of the caves and river gravels. The lecture was illustrated by lime-light views of glaciers, extinct animals, and human implements; and was followed on the succeeding evening by a *conversazione* at the same place, when Mr. Tuckwell exhibited and explained to successive crowds throughout the evening a splendid collection of implements, ranging from the earliest palæolithic to the latest bronze ornaments and weapons, kindly lent without charge by Mr. Bryce Wright, of Regent Street. Both evenings were arranged by the Sunday Lecture Society, which provides popular scientific lectures every Sunday night throughout the winter half of the year in the four largest Board Schools in Birmingham, with special lectures in the Town Hall three times in the year. The lectures, as was the case with Mr. Tuckwell's, are frequently marked by a religious, though not by a sectarian tone; and the crowded audiences consist of persons rarely or never seen in church or chapel.

THE Berlin Academy of Sciences is about to send Dr. Lepsius, Professor of Geology at Darmstadt, with an assistant, to Athens, to make a geological survey of the neighbourhood, and endeavour to decide the question of the origin of the Athenian marbles.

UNDER the presidency of Count Hans Wilczek and the Baron Victor Erlanger, an International Electric Exhibition will be held in Vienna, opening on August 1, and closing on October 31. It will be an undertaking of a private nature, but is specially favoured by the Government.

THERE seems to be a serious decline in the once flourishing oyster fisheries of Denmark. Last year only about two million oysters were taken, which is far below the average, nor was the quality so good as usual. There were no new banks discovered during the year. The most important are now those in the Gulf of Vendsel and at Fladstrand.

THE Smithsonian Institution have received from Dr. Stejneger, who was despatched on a scientific mission to Behring Island some time since, *eleven* fairly perfect crania of the extinct Sirenian Mammal, *Rhytina stelleri*, together with sets of nearly all the other bones of the skeleton.

THE Royal Swedish Geographical Society has decided to appoint a committee, consisting of Professors Nordenskjöld and Gyldén, and Consul Elfwing, to consider the proposal for an international meridian and a common time. This committee has requested Consul Elfwing to draw up the Society's report on the question.

THE eminent Swedish palæontologist, Nathorst, has published the results of his examination of the fossil plants collected by the *Vega* expedition at Mogi, in South Japan. According to Hr. Nathorst these remains belong to the Tertiary period, and while they are older than the Glacial age, they would yet seem to be referable to a time when the climate was colder than at present. This instance of the presence in Eastern Asia of a flora of polar origin shortly before the advent of the Glacial period, is considered especially interesting from the strong evidence which it affords in favour of the theory of the migrations of plants in the early ages of the world's history.

FROM a communication of the results of Herr Håkonson-Hansen's observations of the November auroral displays which is printed in the last number of *Naturen*, we learn that while there were as many as nineteen specially vivid and one ordinary manifestation at Trondhjem in that month, the extraordinary length of time during which the auroræ retained their brightness gave a special character to the phenomena. On every night of the week from the 12th to the 18th inclusive, the heavens were illuminated with the auroral light, which on the 13th appeared as early as 4 p.m., while on the 17th it continued visible from 8 p.m. till 6 a.m. on the following morning. During this period it was found almost impossible to work the telegraphic wires by day or night. The most striking display occurred on the 18th, at 4.30 a.m. when a brilliant corona appeared in the zenith, from which vivid streams of light stretched to the horizon, while luminous waves flowed uninterruptedly from the latter towards the corona, diffusing so strong a light as to enable one with ease to read moderately clear print. On the same day, at Gothenburg, it was found impossible to make the wires act.

Naturen warns its readers not to put implicit faith in the statements made in reference to the large yields of silver, which may be expected from the old silver mines in Nordland. According to the prospectus of a company, which offers the public one thousand shares in the Svenningdal mine, near the little town Mosjö, 162,000 kroner's worth of ore was purchased from the owners in 1881 for the silver works at Freiberg in Saxony, yet, as the writer points out, there were only twenty-five men employed in the mine in the course of that year! It is well known that traces of silver are constantly found in the galena and cadmium yielded by these mines, but this fact even the most daring of speculators must admit to be a very insufficient basis, on which to maintain the numerous companies, amounting, it is said, to one hundred, which are offering the public at home and abroad shares in one, or other of the more or less exhausted mines of Nordland.

THE Anthropological Society of Paris has received from one of its members, Dr. Benzengre, a report of the autopsy of General Skobeleff, from which it would appear that the weight of the brain, according to Broca's system, was 1457, which is considerably above the mean for ordinary adult Europeans of his height (1·73m.) and even slightly above that hitherto given for men of exceptionally great intellect.

DR. WILLIAM H. STONE will give the first of three lectures, at the Royal Institution, on Singing, Speaking, and Stammering, on Saturday next (February 17); and Prof. Robert S. Ball will give the first of four lectures on the Supreme Discoveries in Astronomy, on Tuesday (February 20).

THE Norwegian Government have commissioned Dr. S. A. Buch during the present year to make researches, practical as well as scientific, into the great herring fisheries which annually take place on the west coast of Norway.

THE new mathematical journal, *Acta mathematica* (noticed in another column), published in Stockholm, Berlin, and Paris, has received a subsidy of kr. 1000 from the Swedish Government, while the Danish have granted a sum of 60*l*. a year to the editors in Denmark—Prof. Lorenz, and Drs. Petersen and Zeuthen.

THE U.S. Commissioners of Fish and Fisheries propose to build a large aquarium at Wood's Hole, Mass., in connection with their new station there. The aquarium will be devoted to biological researches of every description. At the adjoining station preparations are being made for the artificial propagation of cod, mackerel, halibut, and other fishes useful for food, and it is expected to hatch annually a thousand millions of cod and of other kinds in proportion.

AT the meeting of the Essex Field Club held on January 27, a resolution was passed condemning the proposed extension of the Great Eastern Railway from Chingford to High Beach. The Club regards it as "wholly unnecessary for the railway to take the route projected, and that it would not fail to prejudicially affect the advantages secured by the Epping Forest Act, which directs that the forest is to be preserved as far as possible in its natural aspect, and the Society hereby authorises the Council to petition Parliament against the project, and to send copies of this Resolution to the Press."

PROF. VERGA has been recently investigating the subject of intemperance in Milan (*Reale Ist. Lomb.*), a vice which seems to be on the increase there. Among other things he notes that suicide and kleptomania are very rare among the drunkards. With regard to the two sexes, he says that women fall much less easily into intemperance than men, and that drunken women belong to the lowest social strata, and show true brutification. Men appear to give themselves to excessive drinking more in the cold season; women in the mild season. Women relapse more frequently and shamefully into drunkenness than men, and more easily remain victims. The female drunkard excites disgust or laughter by her behaviour, but is not dangerous either to herself or to others; the male drunkard alarms by his excesses, and has often to be severely punished.

THE behaviour of the virus of anthrax in the form of spores and in that of the bacterium (*Bacillus anthracis*) under heat and various reagents, has been investigated fully by Signor Perroncito. The results are published in the *Atti della R. Accademia dei Lincei*, and show well how much greater power of resistance the spore has than the bacterium.

THE Jablochkoff light of the Avenue de l'Opera having been extinguished, the Place de Carrousel is the only street now electrically lighted in Paris at the expense of the Municipal Exchequer. But the electric light is every day finding new fields of display; a building company who are erecting a large structure in the Paris will manufacture the light on their own premises for their own use, and sell it to the tenants at moderate rates.

M. THOLLON has sent from Nice to the Academy of Sciences a determination of the velocity of the motion of the great 1882 comet, calculated from the displacement of the spectral rays.

THE action of very diluted nitromuriatic acid (aqua regia) on meat and other animal substances has been recently studied by Signor Pavesi (*Giorn. Farm. Chim.* xxxi. 529), and he finds the substance an excellent preserving agent; meat in pieces of about 1 kg. kept in the liquid in wooden vessels remains unaltered and savoury for years. The meat treated may also be dried at 15° to 20° without undergoing change, apart from a diminution of volume and the appearance of a brown colour. Put for a few hours in water, the meat recovers its original softness and natural colour. The proportions of the acids in the preserving liquid are not given. The method is also adapted to preservation of animal substances for scientific purposes.

TWO shocks of earthquake occurred at Agram, the first at 8.44 p.m. on the 4th and the other about 1 a.m. on the 5th. Both were of a violent character, accompanied, as the former disturbances were, by a rolling, thundering noise underground. The direction of the motion was from north-east and south-west, and each shock lasted about four seconds. No damage has been done hitherto. A telegram from New York, February 5, states that earthquakes have occurred at Bloomington, Illinois, and Wolfborough, New Hampshire, U.S., but no serious consequences are reported.

THE German Aëronautical Society held its general meeting at Berlin on January 13 last. During 1882 no less than 230 proposals, principally relating to the steerage of balloons, were submitted to the Society, none, however, furthering the question in any material way.

A MEMBER of the Paris "École pratique d'acclimatation" has discovered a species of spider on the African coast, the firm and long web of which resembles yellow silk very closely, and is said to be almost as good as the product of real silkworms. The syndicate of the Lyons silk-merchants has closely investigated the matter, and the result is reported as highly favourable. There seems to be no difficulty in the way of acclimatising the new silk-producer in France.

NEWS has been received in Bolivia regarding Dr. Crevaux's mission. It appears that several members of this expedition were not killed, as was formerly reported, but are kept prisoners by the Tabo Indians.

THE Museum of the Berlin Society for Commercial Geography will be opened on April 1 next. From time to time there will be in this museum special exhibitions arranged by foreign states. Several of these are already announced. The best part of the Brazilian exhibition will remain in the Museum.

LIEUT. WISSMANN, the intrepid and successful German traveller, arrived at Cairo on January 1. His route from Loanda, by way of Nyangwe, on the Lualaba River, to Zanzibar, which measures about 3600 kilometres, led him for at least one-third of the distance through unexplored country. He has thus solved some of the enigmas of equatorial Africa. It is the southern half of the Congo basin through which Wissmann passed, and he found this to be most densely populated. This fact is remarkable, as it was entirely unexpected. Wissmann also passed through the land of a tribe of dwarf negroes. On the long and dangerous route from Lake Tanganyika to Zanzibar the traveller met with a most hospitable reception at the hands of the renowned brigand chief Mirambo, who supported him in every respect.

IN our last number we stated that M. Tissandier's electromagnetic machine had given a power of 4 horses per hour; it should have been 4 horse-power.

THE additions to the Zoological Society's Gardens during the past week include a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mrs. Norman; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Mrs. Sims; a Peregrine Falcon (*Falco peregrinus*) from North America, presented by Mr. C. H. Webster; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. G. S. Northcote; four Ceylonese Terrapins (*Clemmys trijuga*) from Ceylon, four —— River Turtles (*Emyda* ——) from India, a Globose Curassow (*Crax globicera* ♀) from South America, deposited; a Blue-cheeked Amazon (*Chrysotis cœligena*) from Guiana, two Maximilian's Parrots (*Pionus maximiliani*) from Brazil, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), two Four-horned Antelopes *Tetraceros quadricornis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

DENNING'S COMET.—Mr. W. E. Plummer, of the University Observatory, Oxford, has made an interesting contribution to a branch of astronomical investigation, in which we have not shone greatly in this country, in the shape of a definitive determination of the elements of the orbit of the comet discovered by Mr. W. F. Denning, of Bristol, on the morning of October 4, 1881, which proved to be one of short period, though not previously observed. Accurate positions were obtained between October 5 and November 19 at Athens, Dun Echt, Harvard College, U.S., Marseilles, Odessa, Oxford, Palermo, Paris, Rome, and Strasburg. Starting with the second ellipse calculated by Dr. Hartwig, which assigned a revolution of 8·884 years, Mr. Plummer compares all the observations with an ephemeris computed therefrom. He then determines, by the method of variation of constants, for four-day intervals, the effect of perturbations by each of the planets from Mercury to Saturn inclusive, during the period of visibility; the influence of the perturbations upon the observed right ascensions and declinations being inferred by calculating the differential coefficients for variation of elements for the particular epochs, and these coefficients were used in the formation of equations of condition. The tabular longitudes of the sun were corrected by the results of observations at the Royal Observatory, Greenwich, supplied by the Astronomer-Royal. Normal equations were then formed and solved in the usual manner by least squares, and a corrected set of elements was thus found. The positions of the comet computed from them, and the positions inferred from the substitution of the corrections to the elements in the original equations of condition, agreed generally, but owing to their considerable amount, and the neglect of terms of the second order in calculating the differential coefficients, the agreement was not exact. Since Mr. Plummer's principal object was the determination of the comet's mean motion, he preferred to obtain the values of the several unknown quantities in terms of the mean motion, so that by successive small variations of this element, accompanied by the corresponding alterations in the others, several sets of elements could be formed, and the preferable orbit selected by direct comparison with the observations. This additional labour adds much to the value of Mr. Plummer's work. He accepts as the most trustworthy guide the sums of the squares of the errors in right ascension and declination, though the two do not correspond to precisely the same value of the mean motion, and so obtains the following definitive orbit:—

Epoch 1881, September 28·5 Greenwich M.T.

	° ′ ″	
Mean anomaly	1 40 35·39	
Longitude of perihelion ...	18 36 12·8	Mean Eq. 1881·0
,, ,, ascending node	65 52 2·0	
Inclination	6 50 22·6	
Angle of eccentricity	56 8 28·4	
Log. semi-axis major	0·6315148	
Period of revolution	3235 days.	

Hence we find (the unit of distance being the earth's mean distance from the sun)—

Semi-axis major ...	4·28070	Eccentricity	0·8304135
,, minor ...	2·38498	Period in years ...	8 8567
Aphelion distance..	7·83545	The perihelion passage Sept. 13·43493 M.T. at Greenwich.	
Perihelion distance	0·72595		

The orbit of this comet is remarkable for the near approach it makes to the orbits of Venus, the Earth, and Jupiter. By Mr.

Plummer's figures it appears that in longitude 223°·4 the comet is distant from the orbit of Jupiter only 0·145, a sufficient explanation of a probable cause of the short period of revolution.

THE GREAT COMET OF 1882.—The positions subjoined are extracted from an ephemeris published by Herr Stechert, of Berlin (*Astron. Nach.* No. 2486), and founded upon the elliptical elements of Dr. Kreutz:—

At Berlin Midnight

	Right Ascension. h. m. s.	Declination. ° ′	Distance from Earth.	Distance from Sun.
February 8	6 1 57	−20 5·8	2·412	3·008
10	6 0 17	19 34·5		
12	5 58 46	19 3·7	2·506	3·063
14	5 57 25	18 33·4		
16	5 56 12	18 3·6	2·602	3·118
18	5 55 8	17 34·4		
20	5 54 13	−17 5·7	2·700	3·172

ASTRONOMICAL TELEGRAMS.—Mr. Spencer F. Baird, Secretary of the Smithsonian Institution, notifies that arrangements have been completed with the Director of the Harvard College Observatory for conducting the system of telegraphic announcements of astronomical discoveries, which was established by the Institution in 1873, and that henceforward the American centre of reception and distribution of telegrams will be "The Harvard College Observatory, Cambridge, Massachusetts," to which all astronomical telegrams should in future be sent.

THE MATTER OF SPACE

OF late years there has been a growing tendency towards the belief that matter is present everywhere throughout the universe, as well in interstitial space as in the bodies of the spheres. Yet an older hypothesis is still widely held. The phenomena of light seem to require some substantial medium in space, but this substance has been viewed as specifically distinct from matter, and named ether. Another class of thinkers has devised still another species of substance. This is required to meet the demands of the new gravitation hypothesis; and consists of excessively minute particles, moving with intense speed, and pressing vigorously on the larger and slower particles of matter. In the past still other species of substance were imagined; heat, electricity, etc., were each ascribed to a specifically distinct substance.

Now, however, the tide has turned, and the inclination is to believe in only a single form of substance. There are, of course, countless distinct conditions produced by the aggregations of substance, and variations from simplicity to complexity, but this may not necessarily require more than a single kind of basic particle, or whatever we may call it. If the substantial contents of space are similar in constitution to the matter of the spheres, their state of existence must be much more simplified. In the spheres we have matter ranging from the simple elementary gases of the atmosphere, through the complex mineral compounds of the solid surface, to the highly compounded organic molecules. In outer space the variation is probably in the opposite direction, and substance may exist there in a condition much more highly disintegrated than the atmospheric gases. This view is not held by all theorists. Dr. Siemens argues that space holds molecules of considerable intricacy, comprising certain terrestrial elements, and their simpler compounds; as to the contents of space we know that there are very numerous solid masses, some of considerable size, others minute, and possibly ranging through many degrees from the largest to the minutest. Yet these really occupy but an inconsiderable portion of space, and apparently originated in solar or planetary orbs.

Such is, briefly stated, the state of knowledge and of hypothesis concerning the substantial contents of space. We need but add the uncertain reasons for arguing the presence of a resisting medium in space, and the necessity of a highly elastic condition of the light-conducting substance, to exhaust the subject so far as yet pursued.

It is held by some that the gravitation energy of the suns and planets is sufficiently great to sweep space of all contiguous material particles, except those solid masses which are saved from this fate by the vigour of their orbital motions. The atmospheres of suns and planets are retained with an energy very greatly in excess of their reverse energy of molecular motion, and therefore it is quite impossible that any of this material should escape into space, or that any similarly-conditioned material should exist contiguous to the spheres without being forced to become atmospheric matter. The centrifugal energy of the earth's atmosphere at the equator is only $\frac{1}{17}$ of that necessary to overcome gravity. The molecules of the atmosphere have also a vigour of heat vibration about equal to their centrifugal energy. Hence the resisting energy of these molecules is far below the gravitative energy, and they are vigorously held.

The question of the possible existence of gravitating matter in interspheral space depends strictly upon that of its motor energy. If the momentum of any particle, or of the whole sum of particles, be insufficient to constitute a centrifugal energy equal or superior to the centripetal energy of gravitation, then the material contents of space must inevitably be drawn into the attracting spheres, as atmospheric substance, and space be denuded of matter. If, on the contrary, the centrifugal energy of these particles be sufficient to resist gravitation, they will remain free, and space continue peopled by matter.

Such gravitative particles, wherever existing in space, could not be for an instant free from the influence of spheral attraction whatever their energy of motion. If this energy be too small, they must be related to the spheres as falling bodies, and must become atmospheric matter. If the two opposite energies be equal, they must be related to the spheres as planetary bodies, and circle in fixed orbits around the centre of attraction. If the centrifugal energy be in excess they must assume the condition of independent cometary bodies, temporarily influenced but not permanently controlled by any sun, and wandering eternally through space.

Such are the three possible conditions of the material contents of space. If the first obtain, space must be denuded of matter; if the second obtain, it will permanently contain matter in a partially elastic state; if the third obtain, it will permanently contain matter in a highly elastic state, since the pressure upon each other of the vigorously centrifugal particles must be great, and may be extreme. Of course no single particle could long retain its direction of motion, as related to any sphere. Constant impacts must constantly vary the directions of molecular motion. But the motion of each particle is successively transferred to a long series of particles, and thus is virtually continued in force and direction. Each motion pursues its course independently, though not as affecting any fixed particle of matter, and each particle aids in the progression of a vast network of motions, proceeding in every direction throughout the universe. Thus each particle, though not actually changing its place, may have motor relations which extend in every direction to the utmost extremes of space. It is a node in an interminable network of motions, and its incessant leaps throughout the limits of its narrow space are each part of a long motor line, which affects successively myriads of particles. So far as the energy of gravitation is concerned the effect upon this incessantly transferred motion is precisely the same as if the motion was confined to a single particle. If it lack energy the motion will be a falling one; if it equal the gravitative energy it will form a closed orbit. If it exceed the gravitative energy it will form an open curve, and be only temporarily controlled by any sphere.

In this interchange of motor energy certain particles may continually decrease in vigour of motion, and if near solar orbs may be drawn in as atmospheric matter. But they can only lose motion by transferring it to others, which would in consequence become more independent of gravity. The sum of motor energies in the universe must persist unchanged, and the aggregation of atmospheric substance around any planet must cause an outflow of motor energy which will increase the motor vigour of exterior particles. In such a case the height of atmosphere in any sphere will depend, partly on the attractive vigour of the sphere, and partly on the average motor vigour of the whole sum of matter. Every contraction and loss of motor energy by any portion of matter will increase the motor energy of remaining matter, and a fixed limit to the atmospheric control of every sphere must result, since in the outer layers of its atmosphere the centrifugal energy of molecular motion must increase until it equals the energy of gravitation.

Can we arrive at any conclusion as to which of the three possible conditions above considered really exists? If so we can answer the question as to the existence of matter as a constant tenant of space, and also reach some conclusions as to the character of its motor conditions.

There is one line of thought which seems to lead to a settlement of this question. If the nebular hypothesis of the formation of solar systems be accepted as true, either wholly or partly, there can be no doubt as to the interspheral status of matter. The conditions of nebular aggregation indisputably settle it.

This hypothesis holds that the matter now concentrated into suns and planets was once more widely disseminated, so that the substance of each sphere occupied a very considerable extent of space. It even declares that the matter of the solar system was a nebulous cloud, extending far beyond the present limits of that system. From this original condition the existing condition of the spheres has arisen, through a continued concentration of matter. But this concentration was constantly opposed by the heat energy of the particles, or, in other words, by their centrifugal momentum. This momentum could be only got rid of by a redistribution of motor energy. If, for illustration, the average momentum of the particles of the nebula was just equivalent to their gravitative energy, then a portion of this energy must radiate or be conducted outwards ere the internal particles could be held prisoners by gravitation. The loss of momentum inwardly must be correlated with an increase of momentum outwardly.

This is a necessary consequence of the heat relations of matter. As substance condenses its capacity for heat decreases, and its temperature rises, hence a difference of temperature must constantly have arisen between the denser and the rarer portions of the nebulous mass, and equality of temperature could be restored only by heat radiation. This radiation still continues, and must continue until condensation ceases, and the temperatures of the spheres and space become equalised, but this is equivalent to declaring that as the particles of the spheres decrease in heat momentum those of interspheral space increase, and if originally the centrifugal and centripetal energies of matter approached equality, they must become unequal, centripetal energy becoming in excess in spheral matter, centrifugal energy in the matter of space. Thus, as a portion of the originally widely distributed nebulous matter lost its heat, and became permanently fixed in place by gravitative attraction, another portion gained heat, became still more independent of gravity, and assumed a state of greater nebulous diffusion than originally. The condensing spheres only denuded space of a portion of the matter which it formerly held, and left the remainder more thinly distributed than before. The spheres, in their concentration, have emitted, and are emitting, a vast energy of motion. This motor energy yet exists in space as a motion of the particles of matter, which therefore press upon each other, or seek to extend their limits, with increasing vigour, so that the elasticity of iinterspheral matter is constantly increasing.

It might be hastily imagined that such an excess of heat vigour in the matter of space over that of the spheres should declare itself in temperature. But it must be remembered that temperature is no measure of the absolute heat contents of matter. Condensation increases, rarefaction decreases, temperature with no necessary change in absolute heat contents. The expression "fire mist," so often applied to the matter of uncondensed nebulæ, gives a very erroneous impression. The matter of the solar system nebula, though containing a high degree of absolute heat, was probably of low temperature. Its great rarity must certainly have greatly decreased its temperature. As a differentiation in this matter took place, one portion becoming condensed, another portion more rarefied, the former must have increased, the latter decreased, in temperature. Eventually the extreme condensation of one portion of this matter, and rarefaction of another, caused an extreme difference in temperature. An excessive radiation from the spheres to space has taken place in consequence, the absolute heat of the former constantly decreasing and that of the latter increasing. But the difference in temperature still continues great, the influence producing it acting much more rapidly than the influence tending to obliterate it. Eventually an equality of temperatures may be produced, but only by the production of a very considerable inequality of absolute heat. This must be the final result of spheral condensation and nebulous rarefaction of exterior matter; namely, equalization of temperature, with a change from the original homogeniety to a great heterogeniety of heat contents.

But we are again brought back to the question of the motor energies of matter. Are they sufficiently great to enable a portion of this matter, when reinforced in motor energy by radiations from the spheres, to defy gravitative attraction and, remain free in space? Undoubtedly so, and much greater than would be simply requisite for the purpose, since we find the matter of the planets, after their immense losses by radiation, still possessed of a considerable excess of motor energy. The earth, for instance, has an orbital motion sufficient to maintain it at a considerable distance from the sun. But the motion of the earth is but the combined motion of its molecules. This motion once existed as independent molecular motion, which in time, under the influence of gravity, became dependent molecular motion. We have already spoken of the fact that the particles of space, in consequence of their heat motions, tend to dart off in straight lines of motion, except in so far as the gravitative attraction of spheres causes these lines to become curved. These lines of motion, so far as individual particles are concerned, are checked by the particles coming into contact with others. The motion, however, proceeds onwards, though it is carried by successive, instead of by single particles. If, however, a number of particles move in company in the same direction, they may move much further as individuals, before transferring their energies. And if an immense mass of particles come to thus move in company their individual excursions may be indefinitely extended. The lines of motion, instead of being continued by successive particles, are continued by the same particles, and molecular motion becomes mass motion. The motion of terrestrial molecules, in their revolution around the sun, resemble those of the molecules in Prof. Brooks vacuum tubes, constituting his "fourth state of matter."

Now the degree of resistance of such a mass to centripetal energy will indicate the degree of resistance of the original uncombined molecules. In the earth the motion of the molecules, thus combined, yields a centrifugal energy sufficient to maintain the earth at its present distance from the sun. But this is only a portion of its molecular energies. Its molecules possess considerable independent motion, and form nodes in lines of radiation that extend in every direction. They have also lost a great vigour of motion by radiation to space. It follows that the original momentum of these molecules must have constituted a centrifugal vigour greatly in excess of their centripetal vigour. It secondarily follows that the momentum of those molecules of the nebula which still exist in space, augmented as it has been by radiations from the spheres, yields a very energetic excess of centrifugal vigour. Many of the comets have a centrifugal energy in excess of the centripetal energy of the sun, yet this represents only a fraction of the energy of their molecules, and a much smaller fraction of the energy of the material particles of space.

The combination of the centrifugal energies of terrestrial particles is due to the fact of a secondary centre of gravity having been formed. The heat velocity of its particles, in excess of that displayed in their revolution around the sun, has become partly a revolution around the earth's axis, and is partly retained as heat vibration. But the heat velocity of the material particles of space is not thus secondarily employed. It is affected by the attraction of the sun, or of the nearest sphere; but evidently, from the considerations above taken, this attraction cannot be sufficient to over-balance the centrifugal energy and cause atmospheric aggregation or even to cause orbital revolution. The particles must have energy sufficient to make them independent of spheral gravity. Their straight lines of motion must become to some degree curved in response to gravity, but cannot become closed curves. Instead of becoming planetary, they remain cometary lines, of very open orbit. For if we imagine the earth to be suddenly restored to its nebulous condition, or its particles to be set free in space, they would possess a velocity of motion much in excess of the earth's orbital velocity. Hence they could not be controlled by the sun. The existing particles of space possess a still much greater velocity, and are therefore much more free from gravitative control.

Certain necessary results of this condition have been considered. The lines of centrifugal motion in space are not confined to single particles as in the earth, but are transferred from particle to particle. The effect, however, is precisely the same; this motion of successive particles is in no respect different in effect from what we would have if a single particle were free to move in the same direction. Each particle moves a certain distance, and then transfers its motion in that direction to another. But it immediately pursues some other direction of motion in response to impact, and this aids in the progressive movement of innumerable lines of motor energy. The great centrifugal vigour of these motions must cause an energetic compressing influence upon interspheral matter, and thus produce an elasticity, sufficient perhaps for the requirements of light radiation.

The lines of motion thus transferred through space cannot be unvarying in their orbital directions. Nature knows no great or small in her processes, and each moving particle of the free matter of space is controlled by the same principles which control the motions of a planet. It is subject to perturbations from lateral attractions, similar to those which draw planets and comets out of their orbits, and completely change the orbit of the latter. And its impacts with other particles yield effects such as would arise in impacts between planets of oppositely moving systems. Action and reaction are equal, in this as in every case. The orbit and the speed of a line of motion may be changed through impact or attractive resistance, but only by its causing an opposite change in some other line. Thus the lines of motor energy referred to are not unvarying in speed and direction, but are unvarying in their sum of correlated speeds and directions. The variations which take place in the orbits of spheres and comets through attractive perturbation, and the greater variations which would take place did spheres come frequently into contact, are precisely similar to those which must occur in the case of interspheral particles, and any change in the direction of one orbit is balanced by an equal opposite change in the direction of another orbit, the balance of motor direction and energy in nature being exactly preserved.

If such a line of motion pursues a cometary ellipse and enters the atmosphere of a globe, it must be affected by friction precisely as if the line of moving particles were a single particle, or a minute comet. It might be obliterated by friction or resistance, as the orbital motion of a falling body is obliterated. But this obliteration is really caused by the opposing energy of opposite lines of molecular motion. The single line of motion may be distributed into a thousand lines differing in direction, but the component of these thousand lines must agree with the original line.

The transfer of motion from particle to particle here indicated may take place through attractive resistance as well as through impact resistance. The original disintegration of the matter of space must have increased, as spheral condensation denuded space of much of its material, and as radiation from the spheres increased its motor energy. If matter thus divided up into smaller and smaller particles, these may have continued as closely contiguous in space as are the molecules of spheral atmospheres. In such a case they may present the conditions of excessive rarity so far as weight of matter is concerned; of close contiguity of particles, sufficient to permit the exercise of attractive energy; of great compression, through their vigour of centrifugal motion, and of intense elastic resistance to compression. These are the conditions necessary for the transfer of the radiations of light and heat. In these radiatures motion is conveyed through space by transfer of vibratory motions, not of impacts. The vibrating particle swings between lateral chains of attraction, and causes a like transverse swing in successive particles with which it is attractively connected. Greater energy here causes only greater width of vibration, not greater rapidity of transfer. The latter depends only on the elasticity of the matter concerned. Impact transfer of motion, on the contrary, must differ in speed with every difference in vigour. It is transferred by the motions of what we know as local heat, similar to the incessantly varied heat motions of gaseous matter. As the particles are unvarying in weight, increased momentum can be gained only by increased rapidity of motion, and the lines of motion thus transferred through space vary in speed with every variation in vigour. Every motion, of every particle of matter, is really a minute portion of an orbit, which represents that of a falling body, of a planet, or of a comet, according to its rapidity. Though the momentum affects successive particles of matter the orbit is contínous, except to the extent that it is varied by perturbations through attraction and impact.

Wherever any influence aids a translation of interspheral matter —causes a wind to blow through space—the lines of motion continue to be conveyed by the same particles. The orbital motions of the spheres are such winds through space; minor aggregations of moving matter may enter the atmosphere of the sun or other globes. But no atmosphere can become permanently increased in this manner; such masses, checked by friction, must yield motion, which flows outward. The centrifugal energy of the molecules of the external atmosphere is thereby increased, and the gain of matter must be balanced by an equal escape of matter at that critical atmospheric limit where centrifugal and centripetal energies are in balance. But any such fall of interspheral matter must aid the radiant emissions of the sun. Its loss of proper motion, its high degree of absolute heat, its increased temperature through condensation, and its consequent radiation, would make it a source of solar heat. Any such cometary matter must form part of "The Fuel of the Sun."

Philadelphia, U.S. CHARLES MORRIS

THE INSTITUTION OF MECHANICAL ENGINEERS

THE Annual General Meeting of this Institution was held on January 25 and 26, at the Institution of Civil Engineers, Great George Street; and the papers read were of unusual interest, from a scientific point of view, for a society whose aims are so distinctly practical. As it was pointed out by the president, Mr. Westmacott, three out of the five papers on the list were contributed by professors of science, and dealt with aspects more or less theoretical of the subjects treated upon. This forms, in fact, an additional instance of the way in which the old barriers between theory and practice are breaking down, and it is everywhere becoming recognised that neither can flourish without the aid of the other.

The first two papers, though quite independent, were both evolved, as it were, out of the same subject, namely, the research which the Institution has for some time been carrying on into the properties of hardened and unhardened steel. The first of these is an *interim* report by Prof. Abel, C.B., F.R.S., on the present stage of his experiments relating to the condition in which carbon exists in steel. Preliminary trials had shown that the treatment of steel and iron by a chromic acid solution (produced by mixing a solution of potassium bichromate, saturated in the cold, with one-twentieth of its volume of pure concentrated sulphuric acid) gave great promise of success in detecting the chemical differences existing in the same steel, according to the treatment to which it has been subjected. When cold—rolled, and annealed steel was thus treated, it yielded considerable amounts of an insoluble residue, consisting of black spangly particles, strongly attracted by the magnet, and presenting the characteristics of a true carbide, to which was assigned provisionally the formula Fe_6C_5. With hardened steel, on the other hand, but a small quantity of such particles were obtained, mixed with a lighter sediment; and the total residue contained only about one-sixth the carbon in the original steel, whereas in the annealed samples nearly all the original carbon was detected in the residue. The theory to which this points clearly is that in soft steel the carbon exists in a state of chemical combination, forming a carbide which is disseminated as a separate body through the mass of the iron; but that in hard steel this combination is dissolved, and the carbon exists in its pure form, either merely in mechanical admixture, as in the case of grey cast-iron, or in that peculiar and not very well understood form of association which metallurgists term an alloy. It would follow that the process of tempering, or rapid cooling, does not leave time for the complete formation of the carbide, and that in tempered steel all or some of the carbon still survives in its free or alloyed condition.

The fresh experiments described by Prof. Abel give, on the whole, great support to this theory. Four preparations were made of steel dissolved in chromic acid solution made as above, but of different degrees of strength. In the last only, where the strength was very high, were the results different, showing that the carbide had not been able to resist the oxidising effects of the solution. In the others, a considerable deposit was found, which, after being kept for several days, first in the original and afterwards in a fresh solution, was washed and dried, and then analysed. Another portion of the same was treated with chlorhydric acid, in order to ascertain what proportion would be converted into hydrocarbon. When this proportion was deducted from the whole, the remainder showed a most remarkable uniformity of composition, the percentages of carbon in three experiments being 5·93, 5·94, and 6·00 respectively. It seems evident that we have here a definite compound, to which Prof. Abel gives the formula Fe_3C. The deviations from this exact composition he accounts for by the presence of a certain amount of water, indicating that a carbo-hydrate had been formed, probably as a result of the action on the carbide first separated.

Prof. Hughes's paper, which was illustrated by a series of very striking and elegant experiments, performed with the simplest apparatus, may be considered, in its result, as the complement of Prof. Abel's. The latter goes to show that in soft steel the carbon is present as a chemical compound, which is dissolved by hardening; the former, that in hard steel the carbon is present as an alloy, varying with the temper. Between the two, we seem to reach the threshold of a complete theory. They approach the subject, however, from different sides, Prof. Hughes's work being purely electrical, Prof. Abel's purely chemical; and this makes their convergence the more important. Finding that the induction balance was equally sensitive to molecular and to chemical changes, in the metals tested, Prof. Hughes set himself to devise an instrument by which to examine the former class of phenomena by themselves. A wire forming the core of an ordinary magnetic coil, and capable of being shifted, twisted, &c., as desired, supplies what he requires. The coil is joined to a galvanometer, or, better still, to a telephone; the wire is joined to a battery, and currents are sent through it. So long as the wire is at right angles to the coil, no effect is produced; but if we set it at an angle to the coil, sounds are instantly heard, betokening the presence of induced currents in the coil. This is the ordinary effect of electro-magnetic induction, as discovered by Faraday. Now, instead of shifting the wire, let us give it a slight twist, say of 40°: the sounds are instantly heard as before, and we detect induced currents, which are positive for right-hand torsion, negative for left-hand torsion. Prof. Hughes's explanation of this is that the molecules of the wire, which he regards as so many separate magnets, have been given a twist round the axis, and thus set at an angle to the coil, just as the whole wire was by the shifting in the first case. Now let us twist the wire still further, even to several complete turns. No greater strength of current is observed, showing that the angle once given to the molecules is not exceeded, and that the subsequent torsion is of the wire as a whole. Approach to the wire, thus twisted, one pole of a natural magnet, laid parallel to the wire: the sounds cease, indicating that the magnetism has spun the molecules back again to their original directions. Approach the magnet at right angles to the wire: the current returns to zero while it is still two inches distant, and when it is in contact there is a reversed current, which is then at its maximum. Lastly, removing the magnet, untwist the wire by some 40°: the current returns to zero, showing that the molecular torsion has disappeared, while the molar torsion remains almost the same as before.

In all these effects the wire has been supposed to be of soft iron: a remarkable difference appears when we turn to tempered steel. For we now fail to detect more than slight traces of molecular disturbance or rotation, no matter how many turns we give to the wire. Thus, whereas in the iron we appear to have great molecular freedom, with steel we have almost complete molecular rigidity. But this molecular rigidity is found to obtain also in all alloys of steel which have been tested—*e.g.* magnetic oxide, iron and sulphur, iron and tungsten, &c. Hence we draw the conclusion that tempered steel is likewise an alloy, the associated elements in this case being, of course, iron and carbon.

The above is the essential part of this striking paper; but the same idea of molecular freedom and rigidity was illustrated by other examples. Thus, if a tube nearly filled with iron filings be magnetised, the magnetism, though permanent so long as the tube is still, is removed in an instant by shaking, or even by turning the tube gently, so that the filings roll over each other. If, however, we pour in any viscous liquid, the magnetism can indeed be imparted, but it cannot be mechanically removed: the filings are no longer able to revolve back into their former positions. Again, we may magnetise an iron and a steel wire to the same degree, and then give each a slight pull to set it in vibration; it will be found that almost the whole of the magnetism has disappeared in the iron, while it is scarcely affected in the steel. By such illustrations the remarkable physical differences thus shown to exist between iron and steel were brought very clearly home to the audience; and whether they accepted or not the theoretical explanation, they could not fail to recognise the suggestive and practical character of the facts thus put before them.

The third paper on the list, by Mr. Chas. Cochrane, was a sequel to one read by the same author at the Leeds meeting of the Institution, and dealt with Blast-Furnace working, with special reference to the analysis of the escaping gases. It was laid down at the outset that economy of fuel in blast-furnaces is governed by three conditions: (1) the temperature of the blast; (2) that of the escaping gases; (3) the quantity of carbon which can be maintained in the condition, once attained, of carbonic acid, instead of being re-transformed into carbonic oxide by absorption of carbon in the fuel. On the first two of these heads there is, of course, nothing new to be said; but they were illustrated by elaborate and valuable tables, giving, in units of fuel (C burnt to CO), (*a*) the heat carried *in* by blast of a given weight and temperature, (*b*) the heat carried *out* by escaping gases of given weight and temperature. The third is dwelt on at some length; and tables are given, showing, for any given consumption of C per ton of pig, the ratio of CO_2 to CO in the escaping gases, first when all the CO_2, once formed, is retained in that condition; and afterwards when ½ cwt., 1 cwt., 1½ cwt., &c., are afterwards reconverted into CO, or, as the author terms it, when a *transfer* of ½ cwt., 1 cwt., &c., of C has taken place. From this is deduced the conclusion that the mere knowledge of the ratio of CO_2 to CO in the escaping gases, as given by analysis, is useless to indicate what is really going on in the furnace; because the same ratio may appertain to any different conditions, according to the amount of the transfer which has taken place, from CO_2 back to CO. If, however, the consumption of carbon per ton of pig-iron has been at the same time ascertained, then we are at once able to refer the case to its proper position; and the knowledge of the ratio between the two cases enables us at once to see what amount of transfer has been going on, and what prospect there is of effecting an improvement. It was further pointed out that the main causes of this injurious re-conversion of CO_2 into CO were (1) the fact that the limestone, used as flux, contains a proportion of CO_2, which can only be evolved at a red heat, and therefore in contact with red-hot coke, which immediately gives up some of its C to the evolved gases; (2) the fact that the ore, especially in the larger pieces, does not get completely de-oxidised until it reaches the red-hot region, where the CO ascending in the furnace first unites with the oxygen in the ore to form CO_2, and then absorbs another equivalent of C from the coke, so returning again to the condition of CO. It is therefore suggested that both these sources of evil might be removed if (1) the limestone were *calcined* before entering the furnace, so as to have already parted with its oxygen, (2) the ironstone were broken up into pieces small enough to insure their decomposition in the higher parts of the furnace. Another means of accomplishing the latter result was to increase still further, if necessary, the height of furnaces. A sanguine estimate was made of the economy that would attend the application of these two devices, which it was expected might reach over 3 cwt. of coke per ton of pig-iron made.

The value to ironmasters of the elaborate tables annexed to the paper, and of the mode in which the problem of blast-furnace economy is presented, cannot but be very great; but grave doubts were expressed in the discussion, by Mr. I. Lowthian Bell, F.R.S., whether the practical results would answer the author's expectations. As regards the use of calcined limestone, in particular, it was stated that it had already been tried, without effecting any economy, at least in large furnaces; the suggested reason being that the calcined lime, as soon as charged, re-absorbed CO_2 from the escaping gases, and that although heat was no doubt disengaged in the process, yet this was too near the throat of the furnace to have any serious effect. Moreover it is to be remembered that the previous calcining of the limestone must itself require fuel, the amount of which must be deducted from any apparent gain due to the absence of CO_2 in the lime within the furnace.

The fourth and last paper which was read (one on Screw Shafts, by Prof. Greenhill, of Woolwich, being postponed for want of time) was by a Swiss engineer, Herr Wendelstein of Lucerne, and gave a good and clear account of the mechanical arrangements connected with the construction of the great tunnel under the St. Gothard, the longest in the world. These are beyond our scope; and the important questions of temperature and ventilation, though just touched upon, were reserved for a future communication, which will also deal with the railway approaches. It may be mentioned that the observations of Dr. Stapff, the official geologist at the St. Gothard, were stated to give as the rate of increase of heat in that locality, 2° C. per 100 metres depth (1·1 Fahr. per 100 feet); and that, if this figure be applied to the Simplon tunnel, as at present proposed to be made just above Brieg, the heat to be dealt with would reach the very high figure of 47° C., or 116° Fahr.

THE QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE

THE January number of this well-known scientific periodical appears in so new a form as to call for special notice. Under the editorship of Prof. R. Lankester it has long since attained a very high standpoint among the high-class journals of Europe, but it wanted a little in its general get-up to bring it to the very highest level of these, in such details as size, paper, and illustrations. No doubt such details are not to be taken for more than they are worth, and of late years it will be conceded by all those whose opinion is worth having that the value of the contents of the quarterly numbers of the journal left it in a great measure independent of mere typographical superfluities. Still it is very pleasant to find this eighty-ninth number of the New Series so splendidly got up—its paper and type are such as we might expect to find associated with some special monograph; while the increased size (royal octavo) enables the illustrations to be given on a scale quite up to anything we have been accustomed to in the very first of the German and French journals. Let us hope that the enterprise of both Editor and Publisher will meet with sufficient reward to enable them to continue to show what can be done in the way of a scientific journal in these countries.

That the contents are worthy of such a shrine is beyond dispute. Never has Prof. Lankester issued a more important number of his journal, as a mere enumeration of the contents as follows will show. Dr. E. Klein, On the relation of Pathogenic to Septic Bacteria, as illustrated by Anthrax cultivations. This paper relates to a most serious question: it is a model of fair and judicious criticism of the labours of others, and of skill in experimental details. Our space forbids an allusion to its conclusions; but every medical man of any culture should read and re-read this memoir. Somewhere Claude Bernard has said, "Nowadays every medical man *thinks* himself a physiologist." Such would profit by a perusal of this paper if they are able to understand its full significance.—E. B. Poulton, M.A., On the tongue of *Perameles nasuta*, with some suggestions as to the origin of taste-bulbs (Plate 1).—Dr. L. Elsberg, Plant-cells and living matter.—F. O. Bower, M.A., Plasmolysis and its bearing upon the relations of cell-wall and protoplasm (Plate 8).—Prof. A. P. Thomas, The life-history of the Liver Fluke (*Fasciola hepatica*), (Plates 2 and 3); a most elaborate, complete, and beautifully illustrated monograph.—W. F. R. Weldon, B.A., Note on the early development of *Lacerta muralis* (Plates 4-6).—R. V. Willemoes-Suhm (the late), On a crustaceous larva, at one time supposed to be the larva of Limulus (Plate 7).—A. G. Bourne, B.Sc., On Haplobranchus, a new genus of Capitobranchiate annelids (Plate 9).—E. Ray Lankester, M.A., and A. G. Bourne, B.Sc., The minute structure of the lateral and the central eyes of Scorpio and of Limulus (Plates 10-12). The authors find, in the essential agreement of the central eyes of Limulus with those of Scorpions, another important detail, which confirms the opinion of Prof. Lankester, that the Scorpions and King Crabs are closely-allied representatives of one class, the Arachnida.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—Dr. E. B. Tylor's first lecture on Anthropology will take place on Thursday, February 15, at 2.30 p.m., at the large lecture room at the University Museum, not on Wednesday, the 14th, as previously announced. The second lecture will be given at the same hour and place on Wednesday, the 21st.

The voting for "elected members" of the new Boards of Faculties took place last Saturday. The electors were the Members of Convocation, authorised by the Colleges to teach in the subjects of the various faculties. Mathematics and Natural Science are included in one faculty—that of Natural Science. As there are more college lecturers in Mathematics than in Natural Science, it was resolved at a preliminary meeting of the electors to choose five mathematicians and five teachers of Natural Science to occupy the ten places which were to be filled up. Ten names were then agreed upon, but at the formal meeting another mathematician and another scientist were proposed so that it became necessary to vote. The ten names before agreed upon were those chosen, the mathematicians naturally heading the list. They are Messrs. W. Esson, F.R.S., Merton, C. J. Faulkner, University, C. Leudesdorf, Pembroke, E. B. Elliott, Queen's, and J. W. Russell, Balliol, as representatives of mathematics; Messrs. R. E. Baynes, Christ Church, as a representative of Physics; Messrs. J. Watts, Merton, and A. G. Vernon Harcourt, F.R.S., Christ Church, as representatives of Chemistry; and Messrs. E. B. Poulton, Keble, and W. H. Jackson, New, as representatives of Biology.

The Professors of Mathematics and Natural Science are *ex officio* members of the Board.

The Examiners for the Radcliffe Travelling Fellowship give notice that the examination will commence at the Museum on February 13.

The Examiners for the Burdett-Coutts Geological Scholarship give notice that the examination will commence on February 12.

The serious illness of Prof. Henry J. S. Smith is causing much anxiety in the University.

CAMBRIDGE.—The syndicate appointed to frame regulations on the subject of the degree of Doctor in Science or Letters report that they think it important that precautions should be taken to secure that whenever a degree in Science or Letters is granted, the provisions of the statute requiring that the candidate shall have given proof of distinction by some original contribution to the advancement of science or learning have been *bonâ fide* complied with; but they think it undesirable to require from candidates any additional examination or special act or exercise. Considering that it is desirable to encourage the more distinguished graduates to turn their thoughts towards original work at a comparatively early age, and that it is not uncommon for able men to be elected Fellows of the Royal Society at the age of thirty or thereabouts, the Syndicate are of opinion that five years will be a sufficient interval between the degrees of M.A. and D.S. or D.L. The Syndicate think that it is to be wished that some of the older graduates in Arts should proceed to their new degrees. They think that the probability of this would be increased if the seniority of all those who so proceed within a limited time were reserved to them. The Syndicate have carefully considered the difficulty which may arise from the ambiguity of the term "Science." They are of opinion that no regulations can be laid down drawing a clear line between claims for a degree in Science and claims for a degree in Letters.

The Syndicate have drawn up a code of regulations to the effect of the above. The fee to be payable for the degree of either Doctor of Science or Letters to be 20*l*.

Candidates' applications are to be sent to the Chairman of the Special Board of Studies with which their original contribution is most closely connected, specifying the printed contribution or contributions for which the degree is sought. The application is to be considered by a committee, and the contributions reported on by at least two persons, who may be members of the committee or not. If the Special Board report in favour of the candidate, the General Board of Studies is to have a voice in the matter, and if they approve, the Vice-Chancellor is to publish the name as approved.

The following are nominated Electors to the Professorships named:—

Chemistry.—Professors A. W. Williamson, Lord Rayleigh, Dewar, Frankland; Doctors Phear (Emmanuel College), and Ferrers (Caius), Prof. Fuller (of Aberdeen), and Mr. Coutts Trotter.

Jacksonian of Natural Philosophy.—Professors A. W. Williamson, G. G. Stokes, G. D. Liveing, Dr. Hugo Müller, F.R.S., Dr. M. Foster, Mr. P. T. Main, Prof. Fuller (Aberdeen), and Mr. Coutts Trotter.

Cavendish of Experimental Physics.—Sir W. R. Grove, Prof. G. G. Stokes, G. H. Darwin, Sir W. Thomson, R. B. Clifton, G. D. Liveing, James Stuart, and Mr. W. D. Niven.

The Smith's Mathematical Prizes are awarded to Messrs. Welsh, Jesus College (1), and Turner, Trinity College (2).

The Balfour Fund now amounts to about 4130*l*., in addition to the 4000*l*. contributed by his relatives and by Dr. Foster.

DURING last year there entered at the University of Upsala 330 students. In 1881, the number was 312; in 1880, 263; in 1879, 259; in 1878, 243.

SCIENTIFIC SERIALS

Journal de Physique, January, 1883.—On the metallic gratings of Mr. Rowland, by M. Mascart.—*Résumé* of experiments made at the Exhibition of Electricity, on magneto- and dynamo-electric machines, and on electric lights, by M. Potier.—On electric shadows and on various connected phenomena, by M. Righi.—On the surface of the wave, by M. Doyen.—Demonstration of the principle of Archimedes for bodies immersed in various gases, by M. Terquem.

Atti della R. Accademia dei Lincei. Transunti, Vol. xvii., fasc. 1.—On attenuation of the carbuncular virus, by S. Perroncito.—On the tenacity of the carbuncular virus in its forms of spores, or of *Bacillus anthracis*, by the same —On the presence of yttrium in the sphene of syenite of Biellese, by S. Cossa.—New Sicilian fungi, by Srs. Passerini and Beltiami.—On some unpublished propositions of Fermat, by M. Henry.—On the action of chloride of cyanogen on the potassic compound of pyrrol, by Srs. Ciamician, and Dennstedt.

Vol. xvii. Fasc. 2.—On a class of triple systems of orthogonal surface, by S. Bianchi.—Observations of the Venus transit at the Observatory of Campidoglio, by S. Respighi.—Reports on prize competitions.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. Vol. xv. Fasc. xvii.—On compensatory hypertrophy of the kidneys, by S. Golgi.—On drunkenness in Milan (continued), by S. Verga.

Fasc. xix.—Prof. Giacci's "Fundamental theorem in the theory of the canonical equations of motion," by S. Morera.—On drunkenness in Milan (continued), by S. Verga.—On olivil and some of its transformations, by Srs. Körner and Carnelutti.—Congenital pachydactylia from a psychical impression in the mother, by S. Scarenzio.—Observation of the transit of Venus at the Royal Observatory of Brera, on December 6, 1881, by S. Schiaparelli.—Bacteria of anthrax in the fœtus of a heifer that died of the disease, by S. Sangalli. Discussion with S. Golgi.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 1.—"On the Affinities of Thylacoleo," by Prof. Owen, C.B., F.R.S., &c.—Since the appearance of Part IV. of the "Fossil Mammals of Australia" in the *Philosophical Transactions* for 1871, the author has omitted no opportunity of promoting the acquisition of additional evidences. The application of a grant by the Legislature of New South Wales, in aid of further exploration of the Limestone Caverns in Wellington Valley, having been confided to Ed. P. Ramsay, F.L.S., the results have furnished the author with additional evidences, including those which form the subject of the present communication. After a brief exposition of the state of the question at the date of the previous paper, a description is given of the complete dentition of the upper and lower jaws of a mature marsupial lion. This is followed by descriptions of the antibrachial bones and ungual phalanges of the same extinct animal, the characters of those parts of the skeleton being compared with the same parts in feline mammals and in the existing kinds of diprotodont marsupials. The paper concludes with a description of an entire mandible; and the conclusions to be drawn from the shape and position of the articular condyles, which harmonise with those deducible from fragmentary fossils previously described, go nearly to complete the reconstruction of what the author deems to be the most extraordinary of the extinct pouched quadrupeds of Australia.

The paper was accompanied by drawings of the natural size of the fossils described.

In the subsequent discussion the author remarked on the correspondence of spælean phenomena, the proportion of the remains of the old British lion in bone caves of this country being paralleled by that of the Australian carnivore in the antipodean caves. They were the retreat of the destroyer in both localities; and the fragmentary, gnawed condition of the remains of the prey, with usual immaturity of the captured kangaroos of great size, the *Diprotodon australis*, *e.g.*, afforded an instructive analogy.

"Preliminary Note on a Theory of Magnetism based upon New Experimental Researches." By Prof. D. E. Hughes, F.R.S.

In the year 1879 (*Proc. Roy. Soc.*, vol. xxix. p. 56, 1879) I communicated to the Royal Society a paper "On an Induction Currents Balance and Experimental Researches made therewith." I continued my researches into the molecular construction of metallic bodies, and communicated the results then obtained in three separate papers (*Proc. Roy. Soc.*, vol. xxxi. p. 525; vol. xxxii. pp. 25, 213, 1881) bearing upon molecular magnetism.

To investigate the molecular construction of magnets, required again special forms of apparatus, and I have since been engaged upon these, and the researches which they have enabled me to follow.

From numerous researches I have gradually formed a theory of magnetism entirely based upon experimental results, and these have led me to the following conclusions:—

1. That each molecule of a piece of iron, steel, or other magnetic metal is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar-magnet.

2. That each molecule, or its polarity, can be rotated in either direction upon its axis by torsion, stress, or by physical forces, such as magnetism and electricity.

3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity; that it can neither be augmented nor destroyed.

4. That when we have external neutrality, or no apparent magnetism, the molecules, or their polarities, arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circuit of attraction.

5. That when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically in a given direction, producing a north pole if rotated in this direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism, we have still a symmetrical arrangement, but one whose circles of attraction are not completed except through an external armature joining both poles.

The experimental evidences of the above theory are extremely numerous, and appear so conclusive, that I have ventured upon formulating the results in the above theory.

I hope in a few weeks to bring before the Royal Society the experimental evidence which has led me to the conclusions I have named; conclusions which have not been arrived at hastily, but from a long series of research upon the molecular construction of magnetism now extending over several years.

Linnean Society, January 18.—Sir John Lubbock, Bart., F.R.S., president, in the chair.—E. A. L. Batters, A. J Burrows, E. F. Cooper, Prof. J. A. Harker, and G. Lewis, were elected Fellows of the Society.—Mr. H. Grooves called attention to a specimen of *Ranunculus ophioglossifolius* obtained in Hampshire, and therefore new to Britain.—There was exhibited, on behalf of Mr. Jas. Romanis, a live specimen of *Pieris Rapæ*, which had been found fluttering on the window of his house a few days previously.—A paper was read on the fall of branchlets in the aspen (*Populus tremula*) by Samuel G. Shattock. He shows that in this tree and some few others—in contradiction to the majority of exogenous trees—a process takes place termed "cladoptopsis" by the Rev. M. J. Berkeley many years ago. In the small branchlets only disarticulation is effected by a swollen ring of corky tissue at the base, somewhat as in the ordinary fall of leaves.—Mr. A. G. Bourne gave a contribution on the anatomy of Polynoina, pointing out that the *Polynoë grubiana*, very common in the Mediterranean, is only a variety of the *P. clava*, Montague, of our own coasts. The latter itself has certain constant characteristics, and others much more variable.—Prof. P. Martin Duncan read his observations on the Madreporaria, fam. Fungidæ, with special reference to the hard structures. Edwards and Haime described the synapticula as constituting an essential family structure, and also the absence of endothecal dissepiments. Dr. Duncan describes that the ridges of the continuous synapticula with canals between them is limited by solid and also perforate septa, and he delineates the structures. The synapticula are shown to have no relation to the ornamentation on the ridges of the septa. The basal wall is shown to be of synapticular origin, and the foramina in it to relate to the growth of these binding structures.

Physical Society, January 27.—Prof. Clifton, president, in the chair.—New Member, Mr. Hugh E. Harrison.—Prof. G. Carey Foster read a paper on the determination of the ohm, in which he described the various methods which have been used and proposed in determining the B.A. unit of resistance. He also described a method of his own, proposed in 1874, and recently tried with good results. The method consists in balancing the E.M.F. set up in a coil of wire by spinning it in the earth's magnetic field, against the E.M.F. of a battery or other electromotor, in a wire whose resistance is to be determined. The two opposing circuits through this wire, R, are composed, the first of the spinning coil and a zero-galvanoscope, and the second of a battery and an absolute galvanometer; these two circuits meeting at the ends of the wire R. The late Mr. Hockin and Prof. Foster find that the best conditions obtain when the resistance of the absolute galvanometer r is equal to R; the resistance of the zero galvanoscope r_2 equal to $\frac{R}{2} + r_3$, and the resistance of the spinning cord, r_3, many times the battery-resistance, which should be so low as to be practically negligible. The E.M.F. of the battery should be double that of the spinning coil. Many other conditions had to be attended to, as explained by Prof. Foster. With this method, and using a thermo-electric battery giving an E.M.F. of 2·2 volts, the coil was spun at about 1800 revolutions per minute; r was 63 ohms, r_2 was 135, r_3 was 50, and R was 73 in one, and of 80 in another experiment. R was made up by coils on a resistance box. The ohm was determined by two trials to be 1·003 and ·999. This general result is so satisfactory that the experiments will be continued with extra precautions. Mr. Glazebrook called attention to the remarkable agreement between the results of Lord Rayleigh's determinations and his own independent ones. Lord Rayleigh's figures are for the unit, ·9893, ·9865, ·9868, and Mr. Glazebrook's is ·9866, or the mean of Lord Rayleigh's results. He also announced that the Clarendon Laboratory, Cambridge, would soon be in a position to test and certify any resistance coils sent there.—Mr. Walter Baily then read a paper on the spectra formed by curved diffraction gratings. In a diffraction grating ruled on a portion of a cylinder, if r is the distance of a point from the centre of the grating, and θ the angle which a line to the point makes with the perpendicular from the centre of the grating, c the radius of curvature of the grating, and d an arbitrary constant, a series of curves may be drawn in the plane perpendicular to the lines of the grating having as the general equation

$$r^{-1} \cos^2 \theta = c^{-1} \cos \theta + d^{-1}.$$

If a source of light is placed on a point on one of these, curves the foci of the diffracted light lie on the same curve. The curve consists of two loops, one of which gives the spectra of transmitted and the other those of refracted light. When d is infinite, these curves coincide in a circle, the properties of which have been so used by Prof. Rowland in the construction of his diffraction spectroscope. The paper also describes how the position of the spectra on the curves can be determined for any position of the source of light.

Geological Society, January 24.—J. Gwyn Jeffreys, vice-president, in the chair.—Walter Raleigh Browne, Thomas Charles Maggs, Lieut.-Col. William Alexander Ross, and Cecil Carus Wilson, were elected Fellows of the Society.—The following communications were read:—On *Streptelasma Rœmeri*, sp. nov., from the Wenlock shale, by Prof. P. Martin Duncan, F.R.S., V.P.G.S.—On *Cyathophyllum Fletcheri*, Edw. and H., sp., by Prof. P. Martin Duncan, F.R.S., V.P.G.S.—On the fossil Madreporia of the Great Oolite of the counties of Gloucester and Oxford, by Robert F. Tomes, F.G.S.

Institution of Civil Engineers, January 30.—Mr. Brunlees, president, in the chair.—The paper read was on "Mild Steel for the Fire-boxes of Locomotive Engines in the United States of America," by Mr. John Fernie, M.Inst.C.E.

SYDNEY

Linnean Society of New South Wales, November 29, 1882.—Dr. James C. Cox, president in the chair.—The following papers were read:—"Description of two new birds of Queensland," by Charles W. De Vis, B.A.—One of these birds —*Prionodura Newtoniana* constitutes a new genus and species of the Family Paradiseidæ. It is described from a unique specimen taken in Tully River scrubs, Rockingham Bay. The other bird described—*Cracticus rufescens* came from the same locality.—"Fungi aliquot Australiæ Orientalis," by the Rev. Carl Kalchbrenner.—The following new species were described *Agaricus megalotheles*, *Agaricus Kirtoni*, *A. peltastes*, and *Scleroderma pileolatum*.—The Rev. J. E. Tenison-Woods, vice-president, read the fifth part of his "Botanical Notes on Queensland."—This paper consisted of a description of the "Brigalow" scrubs, which consist mainly of *Acacia harpophylla* (F.v.M.) instead of *A. excelsa* as usually stated. The brigalow forms thickets of from thirty to eighty feet in height, amongst which a peculiar flora occurs. A list of those collected by the author was given at the end of the paper.—"Contribution to a knowledge of the Fishes of New Guinea" No. 3, by William Macleay, F.L.S., &c.—In this paper Mr. Macleay completes the list of the Fishes sent by Mr. Goldie from Port Moresby, bringing the number up to of species 274. The new species described in the present paper are:—*Platyglossus guttulatus*, *Coris cyanea*, *Pseudoscarus Goldiei*, *Pseudoscarus frontalis*, *Pseudoscarus papuensis*, *Pseudoscarus zonatus*, *Pseudoscarus labiosus*, *Pseudoscarus Moresbyensis*, *Monacanthus nigricans*, *Monacanthus fuliginosus*, *Trygon granulata*, and *Tæniura atra*.—"Notes on the Geology of the Western Coal Fields, No. 2, by Prof. Stephens, M.A.—In this paper Prof. Stephens proceeds to an examination of the Wallerawang, Marangeroo and Capertee conglomerates which leads him directly to the conclusion that the continent oft whose shores the upper marine carboniferous beds were deposited, was a system of high mountain ranges, snow-capped, and under erosion by glaciers which descended to near the level of the sea. It was shown further that all the subsequent formations were of shore or river formation, in plains skirting the mountains, or in valleys penetrating their recesses, and that these were all fresh water deposits, excepting the coal seams themselves, which were subaerial; and that the most recent sedimentary formations in that district was the Hawkesbury Sandstone, also lacustrine in origin, and due like the underlying strata to a continued rise of the lake waters upon the land.—"Note on an Australian species of Phoronis," by William A. Haswell, M.A., B.Sc.—"Note on a curious instance of Symbiosis," by William A. Haswell, M.A., B.Sc.—"Note on the segmental organs of *Aphrodita*," by William A. Haswell, M.A., B.Sc.

BERLIN

Physiological Society, December 29, 1882.—Prof. du Bois Reymond in the chair.—Dr. Pohl-Pincus spoke about the effect of weak local stimulations of the heart, and about the effect of vagus-stimulation upon the heart.—Prof. Quincke of Kiel, who was present as a visitor, spoke upon the physiological part of the results of experiments and observations which he had made upon the life-history of the red blood corpuscles. It is a well-known fact that large cells with numerous pigment-granules occur in the spleen and in the marrow of bones. These cells, as the micro-chemical reaction teaches us, contain a great deal of iron in combination with albumen. The iron-reaction of the spleen and bone-marrow is more pronounced than the number of pigment-cells can explain; and hence Prof. Quincke hypothesizes the presence in both structures of a colourless iron-albumen, which is, on the one hand, the product of the destruction of red corpuscles, and on the other hand forms the material out of which the new red corpuscles are developed. Both these circumstances were verified experimentally; when by frequent transfusions of equal quantities of blood into an animal, the number of the red blood corpuscles was considerably augmented, and, by this means, the destruction of red corpuscles likewise increased, the number of the pigment-cells and the amount of iron-albumen in the spleen and marrow of the bones was also very much increased, and there was present in the capillaries of the liver a consideable quantity of white blood-corpuscles with iron-albumen, which, under normal circumstances are only found in this organ in very small numbers. When, on the other hand, the number of an animal's red blood-corpuscles had been diminished by repeated bleedings, both the number of pigment cells and the amount of iron-albumen in the spleen and marrow was found after a few days to be considerably diminished and reduced to a minimum. While a part of the iron from the disintegrating red blood corpuscles describes a circle forming a reserve for the newly-forming blood-corpuscles, another portion is eliminated from the blood through the urine and bile. In the experiments, in which the destruction of red corpuscles was increased as a consequence of transfusions, it was possible to demonstrate the intermediate stages in the process of the abnormally-large elimination of the iron, as both the liver-cells and the kidney-epithelium gave a quite distinct iron-reaction.—Dr. Schiffer then read two preliminary communications. One of these was npon the poisonous properties of the mammalian urine. When the urine of either carnivorous or herbivorous mammals was injected under the skin of a frog, symptoms of poisoning manifested themselves, to which the frog soon succumbed. Rabbits also exhibited symptoms of poisoning after subcutaneous injection of evaporated urine, which had been deprived of the poisonous potash-salts. Dr. Schiffer is still engaged in the investigation of the isolation of the poison.—The second communication was upon his experiments with curare. The striking inoperativeness of this violent poison, when introduced into the stomach cannot be due, as has up to the present been almost universally accepted, to the absorbed poison being quickly eliminated by the kidney, because Dr. Schiffer's experiments showed that the elimination of this substance through the urine is complete, although very slow, so that the animal, if it would absorb the poison, would have had to succumb long before. When Dr. Schiffer introduced a very large dose—about 2 grms.—of curare, into a stomach which he had ligatured at the pyloric orifice, the animal died in about twenty-two hours, which was far too late for curare poisoning, and far too soon as a consequence of the ligature of the pylorus. When introduced into the small intestine, the continuity of which was interrupted above and below by a ligature, the curare was very quickly absorbed; when the small intestine was only occluded above, only a very little curare was absorbed, this absorption taking place slowly. The large intestine behaved like the small one. From the rectum out, curare was very quickly absorbed. Outside the body, curare diffused very well through a stomach wall. To sum up, the inoperativeness of curare when introduced into the stomach is as yet unexplained.

Paris

Academy of Sciences, January 29.—M. Blanchard in the chair.—The death of M. Sedillot, Member in the Section of Medicine and Surgery, was announced.—Note on the observation of the transit of Venus, by M. Janssen. The conditions were very favourable at the fort du Chateau-Neuf, Oran. Special attention was given to the question as to presence of aqueous vapour in the atmosphere of Venus. This was not demonstrated. Afterwards M. Janssen spent a month at Mecheria, a military station on the high desert plateaux, with the same purpose. The air was so dry and clear that, *e.g.*, Jupiter's satellites could be seen with the naked eye. With very perfect spectroscopic apparatus applied under extremely good conditions, he is yet constrained to great reserve as to the presence of aqueous vapour in Venus's atmosphere. He studied mirage, photographed it several times, and finds its causes, in most cases, to be quite different from those commonly supposed.—On the mechanical and physical composition of the sun (continued), by M. Faye. This relates to spots.—Contributions to the history of the reactions between sulphur, carbon, their oxides, and their salts, by M. Berthelot. The results have a bearing on the reactions produced during explosion of powder.—On the morbid phenomena produced in rabbits by introduction of hydrate of chloral into the ear, by M. Vulpian. The most salient phenomenon is impetuous rotation of the animal on its longitudinal axis; which the author attributes to the inflammation produced in the cavities of the internal ear; to this inflammation, along with more or less broncho-pneumonia, the animals often succumbed. The brain and meninges were not affected, as in the experiment of M. Brown-Séquard, who poured chloroform into the ear. Though the disorders of motility are weakened in time, they are found still to persist in some degree, a month after operation.—Observations on the occasion of a Report of M. Leon Colm, on the mortality produced by typhoid fever in the French army, by M. Vulpian. This Report, by a committee of the Academy of Medicine, throws doubt on the value ot M. Glenard's recent statistics (to show the efficacy of cold baths).—Note on the state of natural sciences and on anthropology in Brazil, by M. de Quatrefages. *Inter alia*, Brazil now devotes, on an average, 16 per cent. of her whole revenue to public education; in one of the twenty-one provinces (Goyaz), the proportion reaches 30 per cent. The National Museum in Rio, dating from 1817, has been wholly reorganised by Dom Pedro, and it is of great value. The Emperor is often present at the lectures there. The Museum has its *Archives*, and M. de Quatrefages indicates the contents of the first four volumes sent him; they reveal great scientific activity. The successful Brazilian Anthropological Exhibition held last year is to be followed by one for the entire Continent.—Note on the determination of the phosphoric acid in arable land, by M. de Gasparin. He describes an easy and rapid method. Arrangements were made in connection with a new annual prize of 1000 francs, provided by a widow, Mme. Francœur; it is to be given "to the author of discoveries or works useful to the progress of the mathematical sciences, pure or applied."—On wounds from fire-arms, called seton-wounds, by M. Guérin. These wounds always contain foreign bodies, from crushing of the tissues, and perhaps particles of cloth, &c.; and the conditions are adverse to immediate cicatrisation. The author adopts (with success)—(1) antiseptic washings with continuous currents, (2) pneumatic occlusion; simultaneously, alternately, or successively, as the case may be.—On a class of functions of two independent variables, by M. Picard.—On the algebraic integration of a class of linear equations, by M. Goursat.—On a theorem of M. Tchébychef, by M. Korkine.—Application of a method given by Legendre, by M. Lipschitz.—Observation of a magnetic storm at Cape Horn, by M. Mascart. This was on November 17 and 18 last. The principal perturbation was simultaneous with that at the Parc St. Maur.—Reply to a note by M. Marcel Deprez, by M. Lévy.—M. Deprez presented a translation of the official Report at the Munich Exhibition, on transport of force by dynamo-electric machines.—Reply to M. Lévy, by MM. Mercadier and Vaschy.—New experiment in electrolysis, by M. Semmola. In proof of the law that the quantity of liquid decomposed in a given time is proportional to the quantity of electricity which passes in that time, he uses a voltameter with three platina electrodes inserted equally apart at the bottom. The current coming by one is caused, by a commutator, to pass either by one of the others or by both.—Researches on the passages of alcoholic liquors through porous bodies (second note), by M. Gal. He investigates the influence of temperature, and nature of membrane, and the case in which the membrane is exclusively in contact with the liquid or with its vapour. An alcoholic liquid in contact with a membrane tends to diminish in degree, instead of concentrating, as Sœmmering affirmed, and as is everywhere taught; and it is the same with its vapour.—On the vapour of carbamide, by M. Isambert.—On sulphite of manganese, by M. Gorgeu.—On new ammonio-cobaltic combinations, by M. Maquenne.—On the crystalline form, specific heat, and atomicity of thorium, by M. Nilson. The crystals form a regular combination between the octahedron and the tetrahedron: the specific heat is 0·02757; the substance is quadrivalent.—On the mutual displacements of bases, &c. (continued), by M. Menschutkine.—Importance of zoological characters furnished by the upper lip in the *Syrphides* (Diptera), by M. Gazagnaire.—On the effects of respiration of air charged with petroleum vapour, by M. Poincaré. Dogs, rabbits, and guinea-pigs were experimented with. Respiration was increased in frequency and amplitude, heart-beats were retarded, (the shock was intensified); there was itchiness, sleepiness, and inappetence. Guinea-pigs alone succumbed, after one to two years.

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