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COLOUR IN NATURE

The Colour Sense: its Origin and Development. An Essay in Comparative Psychology. By Grant Allen, B.A. (London: Trübner and Co., 1879.)

THIS interesting and suggestive work deals with the whole question of colour in nature, and more especially with its manifestations in the organic world and the complex colour reactions between plants and animals. It traces the origin of the colour sense in insects to their visits to primeval flowers in order to feed upon the pollen, and in birds to their seeking for fruits, whose seeds they dispersed and whose colours were developed to attract them. It thus attempts to show that the very existence of most of the brilliant colours of the organic world is due to the influence of the colour sense in animals. The author adopts, with some reservations, Mr. Darwin's theory of sexual selection to account for the colours of most animals, and he endeavours to show that only those groups display beautiful colours in which a taste for colour has been aroused by the influence of flowers, fruits, or brilliant insects, their habitual food. All these subjects are treated in a very thorough manner, with a wealth of illustration, a clearness of style, and a cogency of reasoning, which make up a most attractive volume; and though we may not agree with all the author's conclusions, and may even doubt the accuracy of some of his facts, we cannot but admit that he has placed the whole subject before us in a way that must engage the attention both of the man of science and the general reader. We will now proceed to give an outline of the whole work, dwelling here and there on the more interesting points, and especially on those where we venture to differ from the conclusions arrived at.

After an introductory chapter, the contents of which are above indicated, an excellent account is given of the nature of light, and of those peculiarities of the æther-waves which produce in us the sensations of light and colour. The third chapter deals with the organ of vision, giving an account of its earliest appearance and progressive complexity in the animal kingdom, and of the structure of the eyes of the higher animals, and the relation of their parts to the perception of light and of differences of colour. One of the most important facts here brought out is, that the complex mechanism required to produce vision has been several times independently evolved—the eye of the bee, of the cuttle-fish, and of the eagle have each apparently been separately developed from unlike remote sightless ancestors.

The next chapter is a long and very interesting one, on "Insects and Flowers." It deals with the origin and development of these two classes of organisms and their actions and reactions on each other. It is full of interesting facts; and the discussion of the mode of origin of the colours of flowers by a reference to the conditions under which colour appears normally in living plants is especially instructive; the generalisation being arrived at that the leaves which create or store up energy for the plant are green, while whenever leaves lose this function and become expenders of energy they lose the green tint and acquire various other colours; growing shoots, young leaves, buds, stamens and stigmas, and their protecting scales, are almost always variously coloured. The rudiments of colour being thus always ready in the floral organs, it is not surprising that flowers have been separately developed in monocotyledons and dicotyledons, and also probably many times over in each of these divisions.

In this part of his work the author exhibits his tendency to trust far too much to negative evidence, especially to that afforded by geology. He speaks of the carboniferous epoch as presenting a green jungle of ferns and club-moss, "in which there is no trace of bee or moth or joyous butterfly;" while "scarlet berry and crimson blossom, gorgeous bird, and painted insect were all equally absent from the unvaried panorama of green overhead and brown beneath." As the flora preserved to us in the coal-measures was almost certainly that of swamps only, we cannot possibly tell what existed on the uplands and mountains of that period. The enormous differentiation of flowering plants, and the comparatively little change they seem to have undergone during the whole tertiary period would lead to the inference that they may have already existed in some variety during the carboniferous epoch; while the actual discovery of a butterfly in the lower oolite, and of a well preserved wing of what appears to be a large moth in the carboniferous shales of Belgium,[1] renders it quite possible that coloured flowers and gay butterflies *were* then in existence. The statements as to the time when the different orders of insects first came into being (quoted at p. 68) are quite worthless when we consider how rare must be the conditions leading to the preservation of winged insects, and they are already contradicted by well-known palæontological facts. Another statement that seems equally open to doubt is, that even in early tertiary times there were no orchids (p. 97), a statement founded on the generalisation that entomophilous monocotyledons are later productions than entomophilous dicotyledons, because the perianth of the former is usually less specialised. But surely in orchids the perianth is more highly specialised than in any existing flowers whatever; and if we take into account the world-wide distribution of these plants, their immense richness in genera and species, and their wonderful complexity of structure, we must consider them as among the most ancient instead of the most recent of flowers. They are also exceptions to the general rule of the size of the flower being in inverse proportion to its special adaptation to insect fertilisation; of which the large but simple lilies and tulips as contrasted with the small but complex labiates, are quoted as examples.

The next chapter, on the colour sense in insects, sets forth both the direct and the indirect evidence on this question; such as Sir John Lubbock's experiments on bees and wasps, the mimicking insects which deceive other insects, the clear relation of coloured flowers to the visits of insects, the fact of insects often visiting hundreds of the same species of flower in succession, &c. This chapter concludes with a striking picture of the vast effect which has been produced on the appearance of external nature by insect agency, "which has turned the

[1] *Breyeria borinensis*, "Annales de la Société Entomologique de Belgique," t. xviii. Pl. v. (Photograph).

whole surface of the earth into a boundless flower-garden," supplying insects from year to year with pollen or honey, and itself gaining in return a renewal of life by means of the baits that it offers for their allurement. "If," adds Mr. Allen, "any man can seriously doubt that these changes are really due to a colour sense in the little creatures which live upon the beautiful flowers; if he can imagine that the plant has produced its gorgeous petals for no other purpose than that of suicidal wastefulness; that the *Mantis* has grown into the perfect semblance of a leaf from pure wanton causeless mimicry; that the lurid red of fly-fertilised blossoms bears its likeness to the mangled flesh of animals by a simple freak of creative power; then the whole science and philosophy of the last hundred years have been thrown away upon him, and he may return at leisure to the blind and hopeless chance of the eighteenth century atheists."

The relation of birds and mammals to fruits is next discussed, and this is shown to be in many respects parallel to that of insects and flowers, only those fruits being conspicuously coloured which are edible, and the dispersal of whose seeds is effected by the birds or other animals which eat them. The whole of this subject is very well treated, but the evidence that fruits in general have been modified both in edibility and attractiveness in relation to the animals which feed upon them, is by no means so clear as in the case of flowers. With regard to small and hard-seeded fruits, such as our strawberries, currants, and raspberries, our hips and haws, our yews and cranberries, this is no doubt the case, since they are carried away by birds and vegetate after passing through their bodies. It is also the case with such fruits as the nutmeg, whose bulky seeds pass undigested through the stomachs of the great fruit pigeons, but whether the same rule applies to most of the larger fruits may be doubted except when they have hard, stony seed-coverings, as in the case of plums and apricots, which evidently protect the seeds from being eaten, or, if eaten, from being digested. But the majority of the larger fruits are eaten by mammals, and it is doubtful whether their seeds can survive the process. Such are oranges and shaddocks, and gourds of various kinds, while many large bright-coloured fruits of the tropics do not seem to be eaten at all. Many of these are very round and smooth, and may get dispersed by mere rolling down hill, as occurred with the mango in Jamaica,[1] or by being accidentally disturbed by the feet of animals. It is to be observed, too, that the fruits of trees are usually so abundant that, if eatable, there is no danger of their not being eaten even if uncoloured, as in the case of our acorns, beech-nuts, and chestnuts. An immense number of the tropical fruits eaten by monkeys and parrots are not coloured, and the half-developed seeds are often alone eaten; while in others, as the jack-fruit, bread-fruit, and durian, the large seeds are as eatable as the pulpy mass, and the edible nature of the fruit must be injurious rather than otherwise as leading to the destruction of seeds. This need be no difficulty when we consider that with forest trees, which live for several centuries, there is only vacant space for young trees at long intervals, and thus no rigid selection of seeds takes place tending to secure them from being destroyed as food for animals.

[1] See Sir Joseph Hooker's lecture at the Royal Institution on "The Distribution of the North American Flora."

On account of the fondness of most birds and other animals for the very same fruits which we like best, Mr. Allen maintains the general community of taste in all animals. I have, however, usually found monkeys eating fruits which were very disagreeable to me, and the theory is hardly consistent with the fact that many nauseous fruits are bright-coloured. Thus the *Citrullus colocynthus* of Palestine has a beautiful fruit of the size and colour of an orange, but, according to Canon Tristram, "nauseous beyond description to the taste,"—while the *Solanum sanctum*, generally called the "Dead Sea apple," is almost equally disagreeable, but is of a brilliant red colour. Now if these fruits are eaten by any animals their taste must be very different from ours, while if they are not, these fruits have become strikingly attractive from other causes than to induce animals to eat and disperse them. This latter view is supported by another fruit, also found in Palestine, the *Calotropis procera*, which is as large as an apple and bright yellow, but is full of thin flat seeds winged with exquisitely fine silky filaments. Here, then, the seeds having special powers of dispersal by the wind do not need the aid of animals, yet the fruit is most attractively coloured. This is one of the Apocynaceæ, which are usually poisonous, and I have observed brilliantly coloured fruits of the same order in the tropics, but some of these are known to be eatable. Taking into consideration all the facts, it seems probable that attractive fruits are more abundant among the smaller trees and shrubs of temperate lands than in the forests of the tropics, and that their colours are largely due to those adventitious causes which our author has himself so well elucidated. When their distribution has been aided by birds their colours, their edibility, and the non-digestibility of their seeds would all be increased by natural selection. The dry fruits of herbaceous plants, in which the struggle for existence is probably more severe, have no doubt often been prevented from acquiring bright colours by natural selection in order to protect their seeds, just as so many insects and birds have acquired brown or green protective tints.

A curious point in relation to this question, and one that has not been noticed by our author, is the very different characteristic colours of fruits and flowers. I have tabulated the colours of these, under four heads, taken from two books of manageable size—Hooker's "British Flora" and Mongredien's "Trees and Shrubs for English Plantations." The colours of the two classes I find to be as follows, dividing the purples between the red and blue to the best of my judgment, and taking black among fruits as corresponding to blue in flowers.

Flowers.	White.	Yellow.	Red.	Blue.
British Flora	292	228	168	123
Trees and Shrubs ...	160	73	62	37
Totals	452	301	230	160
Fruits.				
British Flora	2	3	33	24
Trees and Shrubs ...	5	11	35	21
Totals	7	14	68	45

Here we see that white and yellow which immensely preponderate in flowers are very scarce among fruits, among which red and blue (or black) predominate, the two colours which are far less common in flowers. We must

conclude, either that there is not a community of taste in colour between insects and birds, or, that what may be termed the normal colours of both have been more or less intensified and utilised by natural selection in order to attract insects and birds respectively.

The next chapter, on the colour-sense in vertebrates, clearly establishes the fact of the possession of this sense by all vertebrate animals, but more especially by birds and reptiles. The evidence of such a sense in mammalia generally is very scanty, though it undoubtedly exists in monkeys; while there are good reasons for believing that it is more acute in birds than even in ourselves. Birds on the whole need to perceive colour more than any other animals, both because the insects and fruits and buds on which so many of them feed are small variously-coloured objects, and because from their habits they require to see and recognise these objects from a considerable distance. It is therefore a remarkable confirmation of the modern theory—that the cones of the retina are colour organs while the rods are only light organs, that in birds the cones are three times as numerous as the rods, while in mammals they are less numerous. Nocturnal birds, such as owls, however, have very few cones, while nocturnal mammals have none. The *macula lutea*, a central yellow spot consisting largely of cones, is found in man and monkeys only, while it exists in all diurnal birds, and these in addition have their cones furnished with variously-coloured globules, which are supposed to give a still more perfect perception of colour. The eye of the chameleon is as perfect as that of a bird, and this accords with its capacity of colour change, and the extreme accuracy with which it detects and captures insects. Mammals, on the other hand, even the insectivorous and frugivorous kinds, have very little occasion for a refined colour sense, since the great mass of creeping insects are of obscure colours, while the squirrels and allies feed on brown nuts rather than on coloured fruits. The evidence seems to show, therefore, that a tolerably perfect colour-sense has only been attained, among mammalia, in the monkeys and man, while even in these it is probably very inferior to that of birds. It seems probable, therefore, that the prevalence of colour-blindness is really an indication of the colour sense in man having been a comparatively recent development, instead of being, as Mr. Allen thinks, a disease of civilisation. An acute colour sense is certainly not of the first importance to savages; and though our author has adduced valuable evidence that most savages distinguish colours just as well as we do, it is very important to ascertain whether colour-blindness exists among uncivilised peoples to a greater or a less extent than among Europeans.

The next chapter, on the direct action of the colour sense upon the animal integuments, deals with the theory of sexual selection as advanced by Mr Darwin, and endeavours to support it by a variety of general considerations. Many of these arguments are very weak, and are often founded on insufficient or erroneous facts, some of which I shall endeavour to point out. The great aim of this chapter is to prove that the colours of animals are intimately associated with the colours of the objects they feed upon. Butterflies and moths being the most beautifully coloured of all insects and feeding on flowers, is held to be the first great fact in support of this view; and this is backed up by the remark that "the colours of caterpillars are mostly protective, being due to natural selection alone, while those of butterflies are mostly attractive, being largely due to sexual selection." To this we must altogether demur, as slurring over what is really a stupendous difficulty in the way of the theory. So far from the colours of caterpillars being "mostly protective" every entomologist knows that a large number of caterpillars in every part of the world are conspicuously coloured, and what is more to the point that their colours are as brilliant and varied as those of butterflies themselves, if we take into account the nature of their integument, the small amount of surface, and the uniform cylindrical form of their bodies. The caterpillar of *Papilio dissimilis*, for instance, on a bluish green ground has a series of broad irregular longitudinal bands of the richest orange yellow, and between these there are a number of round red spots; while those of many of the Euplæas are adorned with exquisite pink and yellow markings, and with a number of long fleshy processes of equally brilliant colours. Owing to caterpillars being so difficult to preserve, and being rarely collected and figured in their native countries, comparatively few of them are known, but it is certain that they often exhibit the most brilliant hues and the most exquisite patterns; and as they may be said to feed invariably on green leaves, while sexual selection cannot affect them, the natural inference is that the same general laws which produce colour in them are quite sufficient for the production of even more varied hues in the perfect insects, whose expanded wing surfaces, ever varying in size, form, and neuration, offer a field so much better fitted for its development.

In beetles the appearance of colour is also attempted to be correlated with their flower-haunting habits by means of equally doubtful facts. The magnificent Buprestidæ and Longicorns are, as far as my experience goes, almost wholly wood-feeders, frequenting the bark of dead trees, and very rarely found on flowers; the Cleridæ and Silphidæ feeding on dead animal matter, are often brilliantly coloured; and generally in beetles, the absence of colour may be traced to the need of concealment and protection, while whenever a special mode of protection exists, whether by nauseous secretions, hard integuments, rapid flight, or facilities for concealment, then colour appears in infinitely various phases; and this law generally prevails throughout the whole insect-world. In his argument in favour of bright hues being attractive to the opposite sexes of insects, Mr. Allen seems always to forget that it is the male that is attracted to the female, and not *vice versâ;* and when he says (p. 158) that he "cannot see why Mr. Wallace, who allows the attractive nature of colouring in flowers, should deny its attractive nature in the question of sex," I reply, that in flowers colour enables the insect to recognise the species, but no one has ever asserted that insects improve and alter the colour of flowers by their preference for certain varieties of colour irrespective of the honey or pollen produced; and in like manner I maintain that the colour of an insect is a guide to easy recognition by its mate, but that there is not one single particle of evidence to show that minute differences in the colour of the same species are observed by insects, still less that such differences are so important

to them as to lead to the rejection of a healthy and well-organised mate; yet unless this is the case, the whole theory of sexual selection falls to the ground.

Again, the general connection between coloured flowers and coloured insects is by no means so general and constant as Mr. Allen supposes. Perhaps the richest displays of gay flowers in the world are to be found in temperate Australia, in South Africa, and in the South European Alps, yet in all these countries the butterflies are very inferior to those of tropical forests, where flowers are comparatively rare. In the forests of Para, for instance, gay flowers are very scarce, as noticed by Mr. Bates as well as by myself, yet the butterflies are endless in their variety of lovely hues. Of course there *are* bright flowers in the tropics, and as travellers notice these whenever they see them and also notice the handsome butterflies, it is easy to infer, as is here done, that the two invariably go together. We may also remark that the sexual allurement of a peculiar odour given out by special patches of scales on butterflies' wings has been discovered by Fritz Müller in the genera *Mechanitis*, *Dircenna*, and *Thecla*, all very brilliantly coloured groups, a clear indication that colour is not a sexual allurement, or we should find it most developed, not in conjunction with, but in the absence of, the attraction of odour.

We must now pass on to the vertebrates, and we here find very good evidence adduced of the existence of a colour-sense in fishes, reptiles, and birds, as we should expect from the known structure of their eyes; while in the case of mammals it is far less decisive. The attempt to associate the brilliant colours of these animals with their food and surroundings, acting through sexual selection, is, however, what we have now to consider; and though many alleged facts are adduced in support of it, several of them are as doubtful and inconclusive as in the case of insects. We shall confine our attention to the birds, which are the stronghold of the theory, and are so much more completely known than the less highly-organised fishes and reptiles. Mr. Allen claims the parrots as fruit-eaters, but they are really seed-eaters, their bills being specially formed to crack the shells and extract and grind up the kernels of nuts and other fruits. They do not therefore aid in the disposal of seeds, as they feed on brown nuts or unripe green fruits from which they extract the seeds, much more frequently than on coloured ripe fruits. The general green colour of parrots is undoubtedly protective, and this green colour is lost, and vivid tints appear just in proportion as, owing to various conditions, the need of concealment diminishes. This is especially the case in countries where mammals are few and a low type of organisation prevails, as in the Australian region, in Madagascar, and in South America; while in Africa and Asia, where a higher type of organisation prevails, the colours of parrots are more sober and protective. A little further on we find the Australian honey-suckers noted for their magnificent coloration; the fact being that they are decidedly a dull-coloured group, hardly superior to our thrushes, and not equal to our finches. Yet they are as universally flower-feeders as the humming-birds themselves; and the total absence of brilliant colour from these birds, which are *the* characteristic family of Australia, and have been developed in correlation with the brilliant Australian flora, absolutely negatives the idea of colour in birds being dependent on the amount of colour in the food and surroundings of certain groups. Again, the ground-feeding pheasant family are passed over as containing only one brilliant bird, the peacock, whereas it abounds in species of the most gorgeous colour. Such are the Impeyan pheasant of the Himalayas, whose metallic plumage is that of a gigantic sun-bird; the golden pheasant, the silver pheasant, and Reeves' pheasant of China, all unsurpassed for gay and conspicuous colouring; the glorious crimson and white-spotted tragopans, the elegant peacock-pheasants, and the intensely brilliant fire-backed pheasants of the Malay countries—together composing a group of birds whose colours are unsurpassed for beauty and splendour, and thus are directly opposed to the general gloom and absence of colour in their habitual surroundings.

In treating of mammals we find an equal want of discrimination in estimating comparative colour and conspicuousness. The tigers, the zebras, the beautifully marked antelopes, and the spotted deer and giraffes, which are really among the most brightly-coloured of all mammals, are passed over as less beautifully coloured than the squirrels and monkeys, in order to support the theory that arboreal mammals feeding on fruits should be (though unfortunately for the theory they are not) the most brightly coloured. Monkeys, as a rule, are very dingy brown or black, about one or two per cent. of the species having patches of bright colour on the bare skin of various parts of their bodies, while the nut-eating squirrels as a whole are certainly not superior to the grazing antelopes. In the summary of facts given at pages 184 and 185 there are many errors. *Scissirostrum Pagei* does not "belong to a family generally dull," while it is itself decidedly dull-coloured; the "pretty cigana" is a very plain coloured bird; Santarem, of which it is said "the pastures are destitute of flowers, and also of animal life, with the exception of a few small plain-coloured birds," is one of the richest localities for flowering shrubs in South America, and one of the few places where I remember the conspicuously coloured fruits on many of these shrubs, while the butterflies in the adjacent forests are gorgeous in the extreme; and lastly, the "gay-coloured squirrel," for which I myself am made responsible, is one of the dullest of the group, pretty indeed as are all squirrels, owing to its brown and yellowish ringed tail, but in no sense whatever "gay," while I certainly say not a word about its feeding on "bright-coloured fruits."

Such mistakes as these pervade this portion of the work, and are made the foundation for repeated argument and illustration; and they serve to show how impossible it is even for the most earnest and enthusiastic student to make a few months' labour suffice for a correct appreciation of the bearing of the overwhelming mass of facts presented by the countless species of the animal and vegetable world. I have marked a number of other passages to which I altogether demur, but many of them involve arguments which would extend far beyond the limits of an article. For the same reason I can only briefly refer to the concluding chapters on the "Colour Sense in Man," in which the theory of Mr. Gladstone and the German philologists is disproved in a manner which is absolutely conclusive.

In the summary and recapitulation we find all the facts

and arguments we have referred to marshalled in an imposing array, and finally summed up in the following condensed formula :—

"Insects produce flowers. Flowers produce the colour-sense in insects. The colour-sense produces a taste for colour. The taste for colour produces butterflies and brilliant beetles. Birds and mammals produce fruits. Fruits produce a taste for colour in birds and mammals. The taste for colour produces the external hues of humming-birds, parrots, and monkeys. Man's frugivorous ancestry produces in him a similar taste; and that taste produces the final result of human chromatic arts."

Although I totally differ from Mr. Allen's conclusions as to the production of the varied colours of the animal world, I must express the extreme pleasure with which I have read his book, which I most cordially recommend to all who love colour, and can enjoy a thoroughly well-written volume on a most interesting but difficult subject.

ALFRED R. WALLACE

GEODESY

Die geodätischen Hauptpunkte und ihre Coordinaten. Von G. Zachariæ. (Berlin: Oppenheim, 1878.)

THE science of geodesy, though far from a popular one, exercises something like a fascination over its own devotees. It is not a standstill science; how to devise instruments—theodolites, altazimuths—which shall excel their predecessors; how to use these instruments so as to eliminate the sources of possible error they individually present; how, having got the observations, to eliminate in the use of them, their own errors as far as possible; and finally, how, after obtaining final results, to express the degree of reliance to be placed on them: these are all ever-fresh questions, capable, many of them, of engaging—as one may, for instance, see in the works of the late Prof. Hansen—considerable mathematical ability. The work before us is of Danish origin, and it is clear that the Danish meridian arc and the geodetic operations connected therewith have been executed in a thoroughly scientific manner. To those who are employed in geodetic operations, this treatise will be most welcome. In an introductory chapter we have the definitions of the mathematical surface of the earth, expressions for the radius of curvature and various lines connected with the spheroid, and remarks on the deviation of the actual surface from that of a true spheroid. The first section treats of the method of laying out a triangulation, of the measurement of angles, and of the measurement of base lines, together with the calculation of the probable errors of results. The second section deals with the calculation of triangles: after giving Legendre's theorem, the writer shows how spheroidal triangles may be computed as spherical, and gives the expressions for the differences between the angles of a spherical triangle and a spheroidal triangle having sides of the same length, with any position in azimuth. Then the method of calculating a triangulation by least squares is entered into. The third section deals with the subsequent expression of the results in the form of co-ordinates—of the method of calculating differences of latitude and longitude. Throughout the work, in all formulæ which are approximative, the nature or order of the terms omitted is expressed by a neat notation which is very useful. The fourth section is devoted to the measurement of heights, and levelling operations and calculations; the subject is gone into thoroughly, including the investigation of the coefficient of terrestrial refraction and the errors which may accumulate from various sources. The last part of the section is devoted to the consideration of the "Schlussfehler," or "error of close" in levelling. This error may arise from mountain attraction, or may exist even without it. We know that at the surface of the spheroidal earth the equipotential surfaces—take any two of them a few hundreds or thousands of feet apart—are not parallel, but the distance between them at any point is inversely proportional to gravity there. If P, Q be two points on the higher of two equipotential surfaces, p, q, their projections on the lower, then levelling from p to Q, if we in imagination take the path, $p P, P Q$, we have $p P$ as the height of Q above p; then continuing the levelling from Q by the path $Q q$, $q p$, to p, it is clear there will be an error in the close of the levelling of the amount $Q q - P p$. Practically, of course, this is very small. An error of close of levelling may occur in working over a mountain; the attraction of the mountain deflects the vertical, and too small a height is the result; of course if the hill is symmetrically shaped, the same amount of error is involved on both sides, and there would be no discrepancy in results obtained by levelling over and round or through the hill. But generally the error on the two sides is not the same. In the work before us the case is supposed of levelling being carried over a mountain-chain of uniform triangular section. In the triangular section $A B C$, C being the ridge and $A B$ the base, suppose levelling to be started from A the foot of one slope, along a level surface *through* the mountain, or, which is the same, along a level surface round it, to B, a point on the *same* level-surface as A; then up the slope from B to C, then down the other slope from C to the starting-point A. Then the error of close, or the "Schlussfehler," is a certain multiple of the integral of the difference between the horizontal component of the attraction of the hill at any point as P on the slope and the horizontal component of the attraction at p, which is the projection of P on the level surface $A B$, multiplied by the element of horizontal distance, and taken from A to B. So that if we do not misunderstand the writer, the numerical examples of "Schlussfehler," given at p. 290, are very much too large. In fact the before-mentioned multiple of the difference of potential at A and B, when added to the right-hand member of the equation (3) on the page referred to, very nearly cancels that term.

The fifth and last section of the work treats of the influence of small alterations of the spheroid of reference on the reduced triangulation, and of the determination of the elements of that particular spheroid which is most in accord with the results of the triangulation under consideration. The formulæ throughout the work are very neatly developed and the typography is admirable.

A. R. C.

OUR BOOK SHELF

A History of the Birds of Ceylon. By Capt. W. Vincent Legge, R.A. Part I. Imp. 4to. Pp. 1–345. (London: Published by the Author, 1878.)

THE many interesting papers on Ceylonese birds published during the last few years by Capt. Legge in the

Ibis and in the Indian journal *Stray Feathers*, will have prepared his readers for an excellent account of the habits of the birds of that island. The avifauna of Ceylon did not attract the attention of the naturalist to any great extent after the year 1854, when Mr. E. L. Layard published his valuable notes in the *Annals of Natural History*, and brought to light a number of new and interesting forms, until in 1872 Mr. E. W. H. Holdsworth presented to the Zoological Society an excellent memoir, embodying not only all that was known on the subject, but adding greatly to our knowledge from the results of his five years' residence in the island. Ornithologists, however, could hardly have expected from the published accounts that so much would remain for Capt. Legge to do in a field often supposed to be tolerably well exhausted by the labours of the two naturalists mentioned above, and it is impossible to speak in too high terms of the volume which our author has now presented to the public, and which, in our opinion, is one of the best ornithological works ever yet produced. Not only does Capt. Legge excel in his descriptions of the habits of the Ceylonese birds, which he has himself studied in the jungle during his seven years residence in Ceylon, devoting his whole leisure time to the pursuit of ornithology, but on the return of his regiment to England he at once sets to work to complete the scientific history of the birds with whose life-history he is already so well acquainted. The result of the patient labour which he has devoted to both branches of the subject is apparent on every page, and from the peculiar relations of the avifauna of Ceylon this task has been by no means an easy one. Possessing only a limited number of peculiar forms, the birds of Ceylon indicate affinities on the one hand to those of Southern India, and on the other to those of the Malayan Peninsula, while in the higher ranges a decided Himalayan element crops up. Sometimes the differences between the forms of birds inhabiting these regions and Ceylon are found to be of specific importance, but more often the variation does not extend beyond the recognition of a climatic race or sub-species. Not one of these difficult questions is shirked by the author, who diligently compares the subject of every article with the allied forms of surrounding countries, so that many of his descriptions amount to monographic revisions of genera and species of the highest importance to the student of Indian ornithology.

Commenced originally with the idea of providing a handbook to the birds of Ceylon, for the use of the numerous planters and civil servants interested in the study of birds (and Capt. Legge's work shows that these are already a goodly company), this production not only fulfils the author's original purpose, but forms a most valuable addition to the series of similar works, such as Buller's "Birds of New Zealand," Dresser's "Birds of Europe," &c. We regret to see that the great length of the articles, which the conscientious researches of the author have obliged him to write, has already forced him to give to the one part now published no less than 340 pages, which was as much as the entire book was expected to occupy. Involving as this does a serious pecuniary loss, we feel bound to call attention to the fact, as evidencing the self-sacrificing enthusiasm with which Capt. Legge regards his subject, and when we state that the coloured plates, which give illustrations of every peculiar Ceylonese species, are in Mr. Keuleman's very best style, we can add nothing more to recommend the work to the attention of the scientific public. R. BOWDLER SHARPE

Sur la Structure et les Modes de Fécondation des Fleurs. Par L. Errera et G. Gevaert. 1° partie. (Bruxelles, Mayolez, 1879.)

IF the value of a work is to be judged by the extent of the original research to which it has given birth, then surely few have been published possessing so high a value as those of Mr. Darwin. The little volume before us is a direct outcome of attention directed by Darwin's writings to the subject of the fertilisation of flowers. Without pretending to any novel discovery, it gives a clear and succinct *résumé* of our present state of knowledge of the subject, the writers themselves confirming Darwin's observations on some important points. Appended is an interesting morphological study and comparison of two species of *Pentstemon*, *P. hartwegi* and *gentianoides*, of which the authors consider the latter to be a derivative from the former. They regard the natural order Scrophulariaceæ as being the offspring of certain forms belonging to the Solanaceæ.

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.*]

Deltaic Growth

THERE can be no doubt that there are conditions very favourable to the rapid deposition of sediment brought down by the Irrawaddy, Sittang, and Salween rivers, in the Gulf of Martaban—as a reference to the map will show—but the amount can hardly be as great as that afforded by the following results, which, I anticipate, may be of some interest to your readers.

While proceeding northwards towards Rangoon from Penang, in the s.s. *Fitzpatrick*, Commander Humphries, I observed, shortly after we entered, discoloured or muddy water in the open sea, lat. 15° 15′ N.; the soundings taken were only from fifteen to sixteen fathoms in places where the Admiralty charts showed from thirty-two to thirty-four fathoms, just *double*, or a difference of 100 feet.

The chart was based on surveys originally made by Captains Ross and Crawford, probably thirty years back, and lately issued in an amended form, supposed to have been "corrected to date." PAT. DOYLE

Jordan's Hotel, Rangoon, February 27

Atmospheric Pressure

DANS le No. de la NATURE de 6 courant, p. 420, àpropos d'une appréciation des observations météorologiques de *l'Hydrographic Office* à Pola, on lit le suivant:—

"The amount of this third maximum is very small, and the evidence yet adduced is not sufficient to determine whether it is a real increase of atmospheric pressure or merely an apparent increase due to undetected instrumental errors."

Nous avons remarqué ce maximum secondaire du baromètre dans une recherche sur les variations diurnes de la pression à Lisbonne, avant de savoir qui M. Ricatscheff avait fait une mémoire sur ce sujet, et nous pouvons affirmer que le dit maximum n'est dû à des erreurs de l'instrument:—

La recherche que nous avons fait a été dans une série de 12 années d'observations horaires, déduites du barographe (système photographique) et nous avons constaté le suivant:

1. Pas une seule des 12 courbes de la pression atmospherique, correspondantes aux 12 mois de décembre ou aux 12 mois de janvier, a laissé d'exhiber le dit maximum secondaire entre les 13 et 15 heures.

2. Les valeurs des erreurs probables des pressions moyennes dans les heures (13, 14, 15) sont encore inférieures aux erreurs probables des autres heures du jour.

3. En groupant les pressions horaires des jours sereins et calmes des mois de janvier et de décembre, pendant toute la série de 12 années, le maximum en question est ressorti plus régulier et beaucoup plus developpé que dans les courbes des pressions moyennes de les mêmes mois. Il me semble donc démontré l'existence de ce maximu n secondaire, très difficile à expliquer, et que rendra plus obscure l'explication de la double oscillation diurne du baromètre. JOAO CAPELLO

Observatorio do Infante D. Luiz, Lisbonne, 14 mars

On the Pupation of the Nymphalidæ

IN NATURE, vol. xvi. p. 502, I called attention to some observations and experiments of mine on the pupation of several species of *Nymphalidæ* and *Pieridæ*, the results of which were: (1) That, in the species referred to, a connection (larvo-pupal ligament) exists between the larva-skin and the chrysalis which is the sole support of the suspensus chrysalis during the final process of pupation, namely, during the extraction of its tail from the larval skin and fastening the anal hooks in the supporting silk; (2) That this ligament is not confined to the *Suspensi*, but exists also in species of the *Succincti* where it has not the same function to perform; and (3) That nevertheless, in these latter cases, when other support is withdrawn by cutting the girdle before pupation, this ligament is capable, in the majority of cases, of fulfilling the same office as it does in the *Suspensi*.

These views have recently received important confirmation and extension at the hands of Mr. W. H. Edwards, of West Virginia. I refer in the first place to a paper of his in the *Canadian Entomologist* for December, 1878, which is reprinted in the *Entomological Monthly Magazine* for the present month. Here Mr. Edwards describes the ligament as found by him in *Grapta interrogationis* and *Danais archippus*. In the latter it is black. Of the former Mr. Edwards writes: "When I lifted the flap of skin entirely clear of the struggling segments, and cut it off a little below the tail, the bendings and contortions were not interrupted by my interference, nor was the effort to reach the silk in the least abated. Held firm by the stretched ligament, which was in plain view, the body rose, and the tail, which had got well outside the padded skin and was, before complete extrication, bent backward, now bent forward, and by the upward swing, was brought exactly to the silk. Several times as I was lifting, the skin and chrysalis together were dislodged, and fell into my hand. Then by drawing the skin back the ligament was exposed, and it was distinctly seen that it was attached to the chrysalis by the pointed ends of the ridges before mentioned and that there was no other connection between skin and chrysalis." As regards the second and third points mentioned above, Mr. Edwards writes to me as follows:—"I experimented on *Papilio ajax* and *P. asterias*, also following your illustration with Pieris, and was successful in discovering the membrane in both species. *Ajax* has the terminal part of the chrysalis remarkably short, but although I cut the band and let the larva hang, the chrysalis generally succeeded in reaching the button of silk. So with *Asterias*, in which the terminal joint is longer. I have no doubt all the Papilionidæ possess this membrane, and probably the Satyridæ."

We have now the existence of the ligament demonstrated in three species of *Suspensi*, viz., *V. urticæ*, *G. interrogationis*, and *D. archippus;* and in three or four *Succincti*, namely, *Pieris brassicæ*, *Papilio ajax*, and *P. asterias*, and probably also in *A. cardamines;* all of which latter also pupate more or less successfully when artificially converted into suspensi by cutting the loop. To the case of *A. cardamines*, which, when pupating as an artificial suspensus, does not remove the tail of the chrysalis from the pocket of the old larva skin, there is a parallel in *Pyrarga egeria*, and perhaps also in *Epinephele janira*, in regard to the former of which Mr. Newman states ("British Butterflies," p. 85):—"The skin of the caterpillar always remains attached to the anal extremity [of the chrysalis], even after the butterfly has escaped." In reference to *Janira* he writes (*op. cit.*, p. 92):—"Three of my specimens changed to chrysalids," &c.; "in two instances the skin of the caterpillar remained, enveloping the anal extremity, so that the chrysalis could not be suspended; in the third it hung for a time from a blade of grass, the skin still enveloping the anal extremity, but attached by its anal hooks to silken threads on the grass."

Mr. Edwards promises further researches during the coming season, for which he has favourable opportunities in his locality, and I think we may confidently look for interesting and perhaps important results. The question of rank in the diurnal lepidoptera is one that has been much contested (see Wallace's essay on "The Malayan Papilionidæ," &c., "Contributions to the Theory of Natural Selection," p. 133), and will probably be decided differently, according to the standard of perfection set up; but the question of *derivation* is probably more capable of definite solution, and on this point the suspensory ligament seems well calculated to afford important guidance. In the meantime more extensive observations and experiments are wanted, and will no doubt be afforded by those interested in the subject when their attention has been once directed to the matter.

Milford, Letterkenny, March 26 J. A. OSBORNE

Tides at Chepstow

I AM unable to find any certain record of "exceptionally high tides" at Chepstow. They must be of rarer occurrence than is commonly supposed. A very high one is mentioned as having flooded the lowest parts of the town January 29, 1846; and a very low neap tide is noted in a wharfinger's books, on March 19, 1876. Measurements of these cannot be obtained; but the highest known rise of the tide at Chepstow since the erection of the iron passenger bridge in 1816, has not exceeded fifty feet; and probably has never attained such an elevation even with the conjunction of much fresh water inland, and a stiff S.S.W. breeze.

Fair proof of the accuracy of this statement is afforded in the elevation of the railway bridge that spans the Wye about two miles and a half from its mouth. By the requirements of the Admiralty, a clear headway of fifty feet had to be left above the highest known tide. Besides attention to these requirements, the contractors had to provide approaches to the roadway of the bridge, involving, on the Gloucestershire side, a long and deep cutting through limestone rock, and on the Monmouthshire side a lofty embankment. A very large outlay of money depended on the determination of the "highest known tide," for it regulated the point of suspension for the bridge, and the level of the approaches. Yet, as may be seen in the official report appended to these notes, *forty-four feet* only were allowed for the "rise of the tide." The readers of NATURE may refer for a drawing of the bridge, plans, and a detailed report, to the *Illustrated London News* of July 24, 1852, to satisfy themselves.

Through the kindness of Mr. Henry Gillam, and of Messrs. Miller, the lessees of the salmon fisheries in the Severn and in the Wye, I have received measurements of this day's tidal range in both rivers, taken personally by those gentlemen. Amongst well-known points I cite the height at Portskewitt landing stage, New Passage, on the Severn, 39 feet 3 inches; at Chepstow railway bridge, 39 feet; at Chepstow Passenger bridge, about a quarter of a mile higher up the river, 35 feet.

In the geographical part of Knight's Cyclopædia, article "Chepstow," the rise of water at Chepstow Bridge at high tide is given as "fifty feet, being the greatest tidal rise in Europe."

The highest reliable measurements that I have met with for the tidal rise in the Severn are 47 feet 6 inches, marked on the Portskewitt landing-stage.

For accidental phenomena affecting the tidal levels, I refer to the following extract from the Bristol Tide Book:—

By a careful comparison of the differences of the predicted and observed heights of tide at Bristol with the contemporaneous heights of the barometer, Mr. Bunt found that a depression of one inch in the mercurial column is accompanied by an elevation of fourteen inches, nearly, in the height of the tide. Hence, by observing the state of the barometer a few hours before high water, we obtain the following correction of the height predicted in the tide table:—

When the barometer stands at (Inches.)		Inches.
28 6	Add to the predicted height	20
29 0		14
29 4		8
29 8		3
30 0		0
30 4	Deduct from the predicted height	6
30 8		11

Our highest tides for 1879 are marked in the table as occurring Monday, March 10, and Tuesday, April 8. JOHN YEATS

Chepstow, March 24

P.S.—Through the kindness of the four brothers Miller, I am this morning in possession of measurements of yesterday's tide in the Severn and Wye, taken, by the request of the firm, at distant stations. I enclose one, at Tintern Abbey, taken by Wm. Bowen, a regular correspondent of the Meteorological Department.

March 25

Tintern Abbey, near Chepstow, March 24

MR. ALEXANDER MILLER

DEAR SIR,—As requested, I have taken the height of the flow of tide this morning and find it 15 feet 1 inch above present level

of river, which is about 2 feet 9 inches above summer low-water level.

Yours truly,
WILLIAM BOWEN

The pier master (W. Mants) at Clevedon, near Weston-super-Mare, reports that he timed the rise of the tide there on March 10 from two hours flood, and found that it flowed thirty feet perpendicular in two hours and forty-five minutes. On March 24 the tide rose thirty-eight feet at the Clevedon Pier Head.

J. Y.

Ice Pearls

A PHENOMENON of singular beauty presented itself on the morning of March 24. A patch of meadow land, several acres in extent, had been inundated so far as to leave, pretty regularly distributed throughout, stalks of last year's grass projecting several inches above the surface of the pond. During the preceding night the temperature had been below freezing-point, but the wind which rippled its surface prevented the pool from freezing, while it alternately raised and depressed the stalks of grass. The water thus collected by the bending and rising grass-heads formed into large shining beads of ice which lay at the point of junction of the stalk and the pool. The effect was as if each projecting stalk had unfolded a white flower floating on the water, and when a gleam of sunshine smote the surface of the pool, the effect was resplendent.

J. SHAW

Tynron, Dumfriesshire

Unscientific Art

MR. COPPOCK'S explanation (NATURE, vol. xix. p. 484) has occurred also to me; but may I be allowed to remind him that in consequence of the internal construction of the marine barometer (the pipette and the contraction in the tube), when it is sloped the mercury rises and falls very slowly. As it naturally rises and falls at a decreasing rate, if the barometer be sloped for a few seconds it takes a comparatively long time for the mercury to resume its original position. I have just sloped one of Adie's marine barometers at 30° from the vertical, and I find it takes more than ten minutes to recover itself. I do not know what may be the actual practice on board ship, but I cannot but think that a plan which renders a barometer useless for ten minutes to another or the same observer must be an unusual one.

JOHN W. BUCK

New Kingswood, Bath, March 28

SCIENCE AND WAR—SIGNALLING BY SUNSHINE

THE use of the heliostat in the field adds one more to the many applications of science made by our soldiers and sailors. Signals by sunshine may be no novelty, but the present Afghan campaign and the Zulu war will henceforth be cited as the first in which the heliostat was employed as an implement of warfare. There can be little question as to its value to the soldier, for it affords at once a ready and far-reaching mode of signalling; but sunshine is an obvious *sine quâ non* to its use. In this country, where the Astronomer-Royal tells us the number of hours of sunshine in the week sometimes does not go beyond the units, the heliostat would furnish but an irregular means of telegraphing, and interruptions in the service would be both frequent and prolonged. But in India, on the other hand, at special seasons, at any rate, sunshine is the rule rather than the exception, and consequently the heliostat furnishes an excellent means of communication which our scientific soldiers have done well to make use of.

Heliostat stations are established at this moment throughout the Khyber Pass, and General Sir Sam. Browne, at Jellalabad, has his orders passed up to him by flashes of light from Peshawur and Ali Musjid. Lord Chelmsford has of late also been furnished with heliostats, in order to provide him with better means of commuication along the Tugela. The plan of working is very simple. The mirror of the heliostat is placed so as to reflect the sun's image to a distant station, and when the instrument has once been set the clockwork arrangement, it need not be said, suffices to maintain the mirror in its proper position. In this way the distant station in question always sees the dazzling ray reflected from the mirror, except when the latter is purposely obscured. The appearance and disappearance of the bright spot or flash constitute the signals. There is no need for any superintendence when once the apparatus has been put in working order, and a trained signalman suffices for the duty. The ordinary Morse alphabet supplies an intelligible code, and no one out of the line of signals can read or understand the message. As a substitute for the dot and dash, which go to make up the ordinary written Morse code, the light is shown for short and long intervals; thus the light shown for a short period followed by a long period signifies A, while B is represented by a long period followed by three short ones; in the case of C, long, short, long, short signals are made in turn, and to form E, the letter most frequently used, the light is permitted to shine for one single short period only.

The intensity of these sunshine signals can scarcely be imagined by any one who has not seen the heliostat in working order, and the distance to which they might be made to travel, could suitable stations be provided, is practically unlimited. But everybody has noticed at one time or another, just before sunset, the light striking vividly against the windows of a house. In this case the burning spot may be seen for miles away, and forms the most striking object in the whole landscape. The heliostat signal is obviously brighter still than this, and the appearance and non-appearance of the light is to be appreciated at ten or twenty miles distant without the aid of telescope or binocular.

Signalling by the aid of a mirror is among the earliest experiments of telegraphy, nor, if we are to believe travellers, is the use of a reflecting surface in this way new in warfare; it is only the heliostat, indeed, which we can claim to have been the first to employ in the field. Several instances are on record of polished metal surfaces being used in this manner by savage nations, and it is but two years ago that the United States forces captured a tribe of Indians to whom the use of the mirror was not unknown. These were the Nez Percés Indians, and, according to latest accounts, they were still confined by the American Government in a camp near Fort Leavensworth, where, however, they were left pretty well to their own devices. According to the *New York Daily Graphic* their chief carried with him a looking-glass, "used to direct military manœuvres in battle, by means of reflected rays of light. Their various significations, however, have never yet been found out by the white man," we are told. These are not likely to have been very complicated. The difficulty, in fact, is not so much in reading light-signals of this kind as to reflect the rays in precisely that direction in which the party for whom they are intended happens to be located. How the chief of the Nez Percés managed to do this with his hand-mirror is rather what "the white man" would like to understand.

One other incident in the history of light-signals deserves to be mentioned. When Admiral Sheriff was stationed at Gibraltar in 1835, he made a series of experiments with a view to employing light as a means of telegraphy. His signals were made by an ordinary toilet looking-glass from his bedroom window, that looked out upon the Mediterranean, and by the aid of this simple apparatus he was enabled to communicate with a friend at Tangiers. His light-signals travelled from "the Rock" right across to the African mainland, a distance of something like twenty miles, and were read and answered without difficulty by his colleague on the opposite shore.

Besides the heliostat, our troops in the field are provided with flags and lamps for signalling by day and night. The flags are made four feet square, so as to be

visible at some distance, and they are white or black, to be used according to circumstances; moreover, the signalmen are furnished both with binoculars and telescopes to enable them to read the signals from remote stations. At night either a bright colza light is made use of, or a spirit flame, into which is blown from to time a mixture of powdered magnesium and resin. A short puff or a long puff constitutes short and long signals, which are displayed, as before, in accordance to the Morse code. Every battalion of infantry and regiment of cavalry in the British army has a proportion of its men trained as signallers, so that these can act at once on taking the field. Their duty is to communicate between outlying pickets and the fighting column, and to do duty where there is no telegraph. For let the field telegraph of an army be ever so well ordered, there is always plenty to do for the army signaller; and he will doubtless find in the heliostat a means of fulfilling these duties with increased efficiency. H. BADEN PRITCHARD

FLOODING THE SAHARA

THE French scheme of turning part of the Algerian Sahara into an inland sea continues to attract considerable attention in France, and scarcely a week passes without some allusion being made to it in the Paris Academy. At a recent sitting M. de Lesseps read a letter from Capt. Roudaire in which the latter gave some details of the results of his sounding of the soil at various points, sands and marls being the beds most commonly met with. At one place, four metres below the surface, plenty of potable water was met with, which will be a great saving in carrying on the work.

At the same sitting MM. Ch. Martens and Ed. Desor presented several considerations against carrying out the plan, their opposition to it being shared by several other French men of science. They have themselves examined part of the ground which it is proposed to put under water, so that their opinions ought to have some weight. While giving every credit to M. Roudaire for the accuracy of the survey which he is carrying out, they, however, point out the difficulty of perfect accuracy, which in this case is all important, in the classic country of mirage, where the surface of the ground is constantly altered and deformed by reflection and refraction. Moreover, they point out that to the south of the projected sea is the Wed-Souf, where are ripened the dates known as Tunis dates, the culture of which is a very special one. The least error in surveying, it is shown, might lead to the destruction of this culture, by allowing the waters of the Mediterranean to penetrate the soil where the date-trees are grown, and thus destroy them. The authors do not attempt to touch the argument that even in historical times part of the Sahara now being surveyed was really a great lake; but they point out that there are proofs that in prehistoric times there must have existed an interior sea, at an epoch when the hydrographical conditions of Europe were very different from what they are now. In 1863, when exploring the region between the oases of Guemar and the south extremity of the Shott Mebrir, they found the gypsum beds of the plateaux ended in regular lines like sedimentary beds, and from the soil they collected the *débris* of shells, truly marine, such as *Buccinum giberrulum*, Lam., and *Balanus miser*, L. Above these shells, in the sand, they found *Cardium edule*, better preserved than they had ever seen it. Thus they found fossils characteristic of salt water, and of those which are a mixture of salt and sweet. The retirement of the waters from the Sahara the authors attribute to the elevation of the land, which is even yet below the level of the Mediterranean, and is to a great extent a network of salt lagoons.

It has been said that the creation of an interior sea, of 13,280 square kilometres, would change the pluviometric condition of the country, and even that of the whole of Algeria. This MM. Martens and Desor regard as a great illusion. Although the laws of the general atmospherical movements are little known, yet it is admitted that the Atlantic is the great reservoir from which come the vapours which are resolved into rain over the European continent. They believe that this is also the case for Africa. The Mediterranean is really only a Gulf of the Atlantic, and they do not believe that an addition of 13,000 kilometres will add anything to its climatic influence. Long calculations have been made as to the quantity of water that would be evaporated by the new sea; but the authors point out that the predominating wind in the region is north, and that if it were rendered either too cold or too moist it would injuriously affect the date-culture carried on in the south. The surroundings of interior seas, like the Caspian and Aral, are steppes noted for their aridity; the shores of the Mediterranean suffer in the same way when, as last year, the rains of the north do not extend to the south. For these reasons MM. Martens and Desor think it would be a mistake to insist on the creation of the interior Saharan Sea.

In a subsequent sitting, however, it should be said, M. Favé endeavoured to show that their fears were groundless, especially with regard to the accuracy of the survey; he thinks that the work in connection with the Suez Canal showed that perfect confidence may be placed in the methods of surveying adopted.

THE LONGEST TUNNEL IN THE WORLD

SCHEMNITZ, the principal mining city of Hungary, has celebrated the opening of the Joseph II. Mining Adit, the deepest gallery of efflux of that place, and the longest subterranean work of this kind in the world.

Its excavation was commenced in the year 1782, during the reign of the Emperor Joseph II., whose name it bears, and has been continued since that time, but with varied energy. The most rapid progress was made within the last five years, so that its completion on September 5th, 1878, was a kind of surprise, and was saluted by guns, which caused a great joy in the city, because it announced a new era for the mining operations of the whole district.

Works of such importance deserve to be installed with solemnity, and a festival was arranged for the purpose on October 20-22, 1878. Prof. Szabó, one of the guests from Budapest, delivered a report to the Royal Hungarian Society of Naturalists, as a representative of that body, and we shall not hesitate to communicate an extract of this.

As the mining operations were progressing in depth, there was at the same time a well regulated system of sinking shafts and driving tunnels employed. The Joseph II. Adit is the eleventh of that kind; it lies 200 metres deeper than the Francis Adit, which was until now the principal gallery of efflux for the mines of Schemnitz. This was excavated between the years 1494 and 1637 to a length of 1,968 metres; but a greater extension was given to it by continuing the works from 1747 till 1765. After this period the mines of Schemnitz proved to be so lucrative, that the idea of undertaking some greater work for securing the future prosperity of the mines was conceived, and so the plan was fixed of driving a tunnel at the deepest possible level, which could convey the waters to the valley of Gran, the lowest point indeed which could be obtained within a practicable distance.

They commenced boring the tunnel west from Schemnitz, near the village of Voznitz, on the left bank of the Gran. The height of it is three metres, the width 1·6 metres. About the lower third is destined to convey off the waters, while the upper two-thirds are separated from this by a platform, and adapted for transporting the ores.

According to the original plan it could have been finished in thirty years at the cost of 1,215,000 florins

The cost per metre would thus have been 87fl. 86kr., and indeed such was the case in the first eleven years; but after the French revolution the value of money was greatly changed, and the prices became so high, that in the next thirty-three years very little was done, the yearly progress not being more than 61·4 metres, and the cost per metre 371fl. 52kr.

From 1826 the works were carried on with greater energy at the cost of 260fl. 40kr. per metre till 1835, when the progress again became slow, and remained so for the next eighteen years, only seventy-two metres being worked yearly, at the cost of 313fl. 45kr. per metre.

But after the middle of the present century the sense of the decline of the mines from their former state of prosperity was so prevalent, that the director of the district, M. Russegger, well known on account of his scientific travels in Europe, Asia, and Africa, proposed that they should again devote greater energy to the works in question, as most of the mines were under water, and the raising of this by machines caused an outlay which the mines were not able to bear. For the next twelve years the yearly progress was 293·2 metres, at the cost of 237fl. 63kr. per metre. During the next five years after Russegger's time only 141·1 metres were worked out yearly.

The Hungarian government has through the last ten years again developed greater activity in this work, and the parliament has at its request granted the yearly sum of 100,000 florins for the purpose.

In the year 1874 there were still 2,326 metres to be worked out, which would under ordinary circumstances have been a task of eleven years; but in 1873 experiments were made in boring with machines, which method was tried for the first time in the Mont Cenis tunnel, with surprising success, then in the St. Gothard railway tunnel, and lastly in the "Sutro" gallery (Nevada). After many trials they succeeded in finding out the most convenient arrangement, and the whole work was done in three and a half years. With this method the entire tunnel could have been finished in 27 years.

The length of the Mont Cenis tunnel is ... 12,233 metres.
" " St. Gothard is ... ... 14,920 metres.
" " Sutro gallery of mines is 6,147 metres.
" " Joseph II. Adit is ... 16,538 metres.

The total cost amounts to 4,599,000 florins.

The importance of this tunnel is very great, firstly as regards *geology*. The geological and orographical literature of that country is very old; Schemnitz has been repeatedly visited by distinguished men of science from all quarters of Europe, but the difficulties and complications of its geological structure are so great that there is still much to be done. One of the greatest obstacles in the way of investigation is that the surface is very seldom well exposed; dense forests and products of decomposition of the rocks cover many of the slopes. The tunnel furnishes a section more than ten miles in length, and gives not only valuable information as to the downward prolongation of the lodes known in the upper levels, but some new ones have been traversed, and the entire series of rocks, with their mutual limits as well as modifications and occasional transitions is to be seen without interruption.

It is important secondly as regards *mining*. A new region has been made accessible, and the master-lodes can now be worked to their full extent, while in past years all activity was absorbed by the unlucrative Adit itself. Now the works again promise a long continuance. All the machines used in raising the waters are put away, and thence an outlay of more than 100,000 florins is saved yearly.

The last and not least advantage consists in enriching the miner with new means of working. The application of mechanical boring may be considered as forming for him a new era, just as did the introduction of gunpowder; he will now much more easily undertake the driving of adit-levels, whenever this is feasible, and so, it is to be hoped, that the neighbouring old mining cities will successively have their galleries of efflux too, which is the essential condition of the restoration of their prosperity in mining.

OUR ASTRONOMICAL COLUMN

BRORSEN'S COMET.—From an observation at Kremsmunster by Prof. Strasser on March 14, it appears that this comet has passed its perihelion several hours later than the time calculated by Dr. Schulze of Dobeln, the corrections to the ephemeris on that date being − 31s. in right ascension and − 3″·5 in declination; yet observations at Rome on February 17 and at Arcetri, Florence, on March 10, give different corrections. For the present, as the ephemeris is sufficiently near for finding the comet, the following positions and distances may be extracted from it :—

oh. Berlin M.T.		Right Ascension. h. m. s.		Declination North. ° ′		Log. distance from Earth.		Log. distance from Sun.
April 4	...	2 55 29	...	25 44	...	9·9789	...	9·7767
" 5	...	2 59 16	...	26 59				
" 6	...	3 3 5	...	28 15	...	9·9663	...	9·7824
" 7	...	3 6 58	...	29 32				
" 8	...	3 10 55	...	30 49	...	9·9538	...	9·7898
" 9	...	3 14 56	...	32 7				
" 10	...	3 19 2	...	33 25	...	9·9415	...	9·7986
" 11	...	3 23 13	...	34 44				
" 12	...	3 27 31	...	36 2	...	9·9295	...	9·8086
" 13	...	3 31 58	...	37 22				
" 14	...	3 36 32	...	38 41	...	9·9179	...	9·8196

On March 10 Dr. Tempel estimated the comet brighter than a star of the eighth magnitude, the theoretical intensity of light at the time being 1·18; the maximum value attained this year is 3·33 on April 14, and during the latter half of April and the whole of May the comet will no doubt be well observed; from April 14 to June 10 it will be constantly above the horizon of Greenwich. At its next return in 1884, its apparent track in the heavens is not likely to be a favourable one for observation, and as long a course of observation as is practicable at the present appearance will be desirable for carrying forward the elements of the orbit to 1890.

MIRA CETI.—In 1879 and 1880 the minima of this variable occur at times when the star will be too near the sun to be observable, but the maxima, according to Argelander's formula of sines, take place under very favourable circumstances for accurate determination, in 1879 on September 11, and in 1880 on August 11. From the observations of Dr. Julius Schmidt at Athens, it appears that this formula, which had given the epochs of maximum in 1876 and 1877 (two) earlier than the observed times by 17·7, 16·8, and 19·4 days respectively, was only in error in this direction four days in 1878.

Among variable stars now favourably situated for observation, may be mentioned Lalande 23617 and 23726, the former has been rated from 6m. to 9m., and the latter from 5m. to 8m. Also Lalande 26211, which has been noted as high as 6m. and as low as 9m.; the variation, however, appears less decided in this case, though Bessel estimated the star 8m.; Lalande's 9m. may perhaps be considered a misprint, as there are known to be similar cases in the "Histoire Céleste."

THE MINOR PLANET HILDA.—A new determination of the orbit of this, the most distant member of the minor planet group, by Kühnert, of Vienna, assigns a period of revolution of 2,861 days, or 7·832 years, and an aphelion distance of 4·52; at this point of its orbit the planet is distant from the orbit of Jupiter only 0·85, so that considerable perturbations are possible. The search for Hilda at the present opposition, so far as we know, has been unsuccessful.

EXPERIMENTAL RESEARCHES ON THE REPULSION RESULTING FROM RADIATION

IN previous papers[1] I have described my earlier experiments with the radiometer, and I then showed that the movement of this instrument was due to the presence of residual gas. I have since examined the repulsion exerted by a standard flame shining on pith and mica disks, coated with various powders, chemical precipitates, &c., and suspended *in vacuo* in a torsion apparatus, and I propose in this and succeeding papers to give an account of these experiments, and of the concluding researches on the repulsion resulting from radiation.

The apparatus I used to get quantitative measurements of the repulsion produced by radiation on various kinds of disks, and coated with different substances, is similar to one I have already described, but in order that the experiments may be better understood, it is shown in Fig. 1. I append the following description :—

a b is a horizontal glass tube containing the beam,

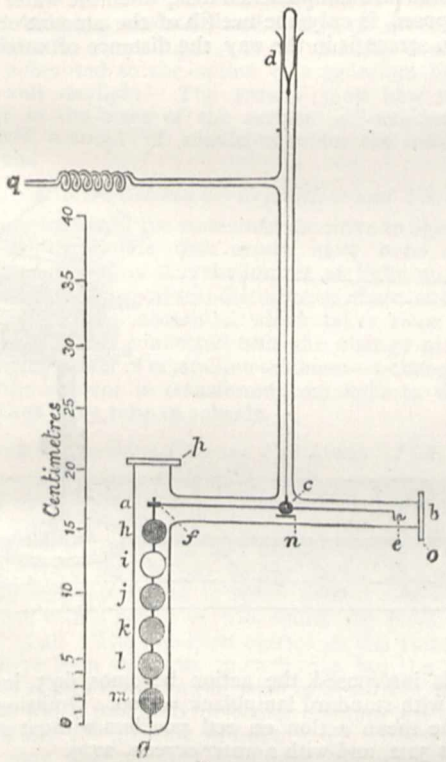

FIG. 1.

which, in this case, is made of straw, so as to secure lightness with absence of flexure under the comparatively heavy weights it sometimes has to bear; *c d* is a fine torsion fibre drawn from flint glass, to which the beam is suspended; it is cemented at *d* to a well-ground stopper, so as to admit of adjustment. When in position, cement, made by fusing together eight parts by weight of resin, and three parts of bees' wax, is run round the stopper. At *c*, the point of junction between the torsion-fibre and the straw beam, is a silvered glass mirror. At the end *e* of the beam, is a small pan to hold the weights counterpoising the disks, which are suspended to the other end. A flat stirrup of aluminium at *f* fits stiffly on the straw beam, and carries a flat glass fibre, *f g*, cemented to it so as to allow of no play, the straw beam, the aluminium hook, and the glass fibre being perfectly rigid. The experimental disks are fixed on the glass fibre by means of a touch of cement at the back. The vertical tube is arranged to hold six disks, the top one, *h*, being always the same standard lamp-blacked pith; the others, *i, j, k, l*, and *m*, being changed each time. A small magnet, *n*, attached to the central mirror, and controlled by a bar-magnet outside, gives the power of bringing the beam to zero, should it happen to get out of adjustment, without having to melt the cement and alter the angle of the torsion fibre by turning the stopper *d*. Plate glass caps at *o* and *p*, cemented to the ground edges of the tubes, give access to the interior; *o* allows the counterpoises to be adjusted in the pan, and *p* allows the aluminium stirrup to be unhooked, and the whole of the disks to be lifted out together. The apparatus is connected to the mercury pump by the arm and spiral *q*. The weights and dimensions of the various parts of the apparatus are as follows :—

Weight of straw beam, mirror, magnetic needle, aluminium stirrup, and flat glass fibre, &c.	7·25 grains.
Average weight of six plain mica disks ...	2·40 ,,
Average weight of six plain pith disks ...	0·59 ,,
Length of straw beam, from centre of counterpoising pan to centre of disks	17·0 centimetres.
Length of arm from centre of suspension to centre of pan	7·6 ,,
Length of arm from centre of suspension to centre of disks	9·4 ,,
Glass torsion fibre—Length	23·0 ,,
,, ,, Thickness	0·0013 inch.
Torsion with a glass weight hanging from it	½ oscillation in 15·75 seconds.

Fig. 2 shows the apparatus fitted up for experimentation. The disks are shown in position at *a*; a brick wall, *b c*, has holes pierced through it in two places, as shown, one hole, *d*, being opposite the centre mirror, and the other, *e*, opposite the disks. The aperture *d* is lined with card, lampblacked inside, and the interstices between it and the bricks are well plugged with cotton wool. A water cell at *d* prevents radiant heat from the lamp getting to the apparatus. Through the hole *e* pass six card tubes, lampblacked internally, 20 millims. diameter, and 23 centims. long. The tubes are firmly cemented to the wall, so that each shall be exactly central with its corresponding disk, and the outer end of each is closed with a cork. The space between the tubes and wall is well stuffed with cotton wool. The apparatus, being once fixed in position, is surrounded on all sides, as well as above and below, with cotton wool. Outside this is a row of glass bottles filled with water, and in front of all is a wooden screen. When protected in this manner, the inside of the apparatus is found to be free from disturbances caused by changes of temperature. When the disks have to be changed, air having been let in through the pump, access is easily obtained to the glass cap *p* (Fig. 1), and the cement being softened by heat, and the cap removed, the disks are lifted out together by seizing the aluminium stirrup with forceps. A fresh set of disks being introduced, the apparatus is again packed up and re-exhausted.

A lamp at *f* throws a narrow beam of light on the mirror of the apparatus, through the aperture *d*. The ray is reflected to the scale *g*, where its deflection from zero shows the angular movement of the torsion beam when one of the disks is repelled by radiation. The scale is 1½ metre from the reflecting mirror.

A standard candle (the kind employed in gas photometry, and defined by Act of Parliament as a "sperm candle of six to the pound, burning at the rate of 120 grs. per hour") is supported on a heavy stand, *h*, and can be raised or lowered by means of the sliding piece, *i*. Another sliding piece, *j*, carries a pointed wire projecting from it. The upright rod of the stand is graduated and numbered, so that when the sliding piece *j* is at mark 1,

[1] NATURE, vol. xv. pp. 224, 299.

the point of the wire is on the prolongation of the axis of tube and disk No. 1, and so on. Then, by sliding the candle up till the most luminous part of the flame is level with the point of the wire, it is known that the light will shine full on the disk under experiment. A half cylinder, *k*, covered with black velvet, protects the candle from draughts. The candle-stand *h* slides along a straight edge, *lm*, screwed to the bench, so graduated that by bringing a mark on the sliding stand to one of the divisions, it indicates the number of millimetres separating the surface of the experimental disk from the centre of the candle flame. The experimental powders are laid on one surface of mica or pith disks as a water paint, no cement being used to promote adhesion. Disks of mica or thin metal were punched, while other materials were cut or filed into the shape of disks 17·25 mm. in diameter.

The exhaustion, which had to be effected after each change of the experimental disks, was carefully brought to the same degree both by actual measurement on a McLeod gauge, and by getting the same repulsion on the standard black disk. In this way all the different results were fairly comparable one with the other. The presence of aqueous vapour was specially guarded against by means of tubes containing phosphoric anhydride.

To show the effect of residual gas intending to equalise the amount of repulsion on variously coloured surfaces, I devised an experiment with pith disks, one being lampblacked and the other retaining its natural white surface, the standard candle being at the same distance in each case. When the exhaustion is good enough to cause a fair repulsion, the ratio between the amplitude of swing when the black is exposed, and that when the white is exposed, is as 100 : 55·5 ; at a little higher exhaustion the ratio is, Black : White : : 100 : 42·5 ; at a still better exhaustion the ratio is, Black : White : : 100 : 35. The results of the quantitative examination of the repulsion resulting from radiation when falling on about 100 different substances I have arranged in fourteen tables, for details of which I must refer to the Bakerian Lecture for 1878. The repulsion is measured, first when no screen is interposed, and secondly, when a cell of water is inserted in the path of the rays. In comparing the two results it must be remembered that the actual amount of repulsion on the standard lampblacked disk, when the water screen is interposed, is only one-twelfth of the amount obtained when no screen is in the way, the distance of candle and

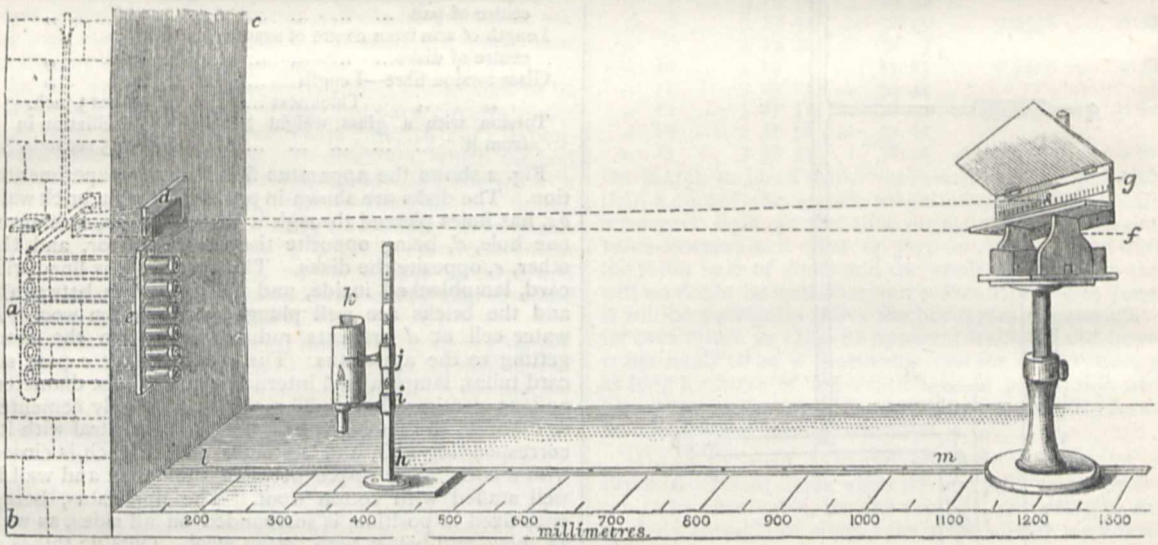

FIG. 2.

other things being equal. In order therefore to compare one with the other the result behind water must be divided by 12.

TABLE I.—*Results of the Examination of Black Powders*

Compared with lampblack = 100 these have an average value of 92·2, which becomes 99·1 by the interposition of water.

TABLE II.—*White Powders*

These have an average value of 33·5, which is reduced to 8·3 behind water. The powerful absorption for the invisible heat rays which white powders exercise is somewhat remarkable. Assuming that the ultra red rays from a candle are almost entirely cut off by a water screen, the comparatively strong action (33·5) produced by the naked flame must be mainly due to the absorption of the invisible heat-rays ; and when these are cut off by water, the action is diminished nearly fifty times. With black powders the water only diminishes the action about eleven times.

TABLE III.—*Red Powders*

Amongst these precipitated selenium is noteworthy. To the naked flame its value is 35·8, but when a water screen is interposed, the action becomes 69·5, in comparison with standard lampblack = 100. Omitting selenium, the mean action on red powders without a water screen is 32·2, and with a water screen, 24·9.

TABLE IV.—*Brown Powders*

Amongst these, peroxide of thallium is remarkable as being repelled under the influence of radiation to a greater extent than any other body hitherto examined, its value being 121·7, in comparison to lampblack = 100. Brown powders behave most like black, the averages of the columns *without* and *with* a water screen being 92·7 and 94·5.

TABLE V.—*Yellow Powders*

Among these, anhydrous tungstic acid resembles scarlet selenium in its anomalous action, the figures being, *without* water, 50·8, and *with* water, 72·2. The averages of the other yellow powders are 35·7, and behind water, 13·8.

TABLE VI.—*Green Powders*

These show some discrepancies, which will be referred to farther on.

TABLE VII.—*Blue Powders*

These show a much stronger proportionate action behind a water screen than with no screen, the averages being 55·8 and 65·2.

TABLE VIII.—*Dyes and Colouring Matters of Organic Origin*

Among these may be noticed saffranin, and a product of the decomposition of chlorophyll, which show an increased ratio or action when the heat-rays are cut off by water. Leaving out these, the mean actions of the other substances are, with no screen, 44·5, with a water-screen interposed, 28·1.

TABLE IX.—*Metals prepared in different Ways and coated with Lampblack, Mica, &c.*

Curious results are shown with iron and with gold, the former metal chiefly absorbing the invisible heat rays, whilst the latter metal is principally acted on by the luminous rays.

TABLES X. AND XA.—*Various Silver Salts*

The chloride, bromide, and iodide of silver in their different states were exposed to the standard candle after being submitted to the action of magnesium light, sunlight, and daylight. The results show how readily a change in the state of the surface is detected by an increased amount of repulsion under the influence of radiation.

TABLE XI.—*Selenium—Crystalline and Vitreous*

The former is in the state most sensitive to light action. With the crystalline disk results have been obtained which seem to show that the impact of light on its surface produces a superficial disturbance there and in the adjacent gaseous molecules, which takes some time to subside. This is connected with the change in electric conducting power of crystalline selenium—a change which, when the element is transferred from light to darkness, also takes some time to subside.

TABLE XII.—*Miscellaneous Substances—Pith, Mica, Charcoal, Glass*

The complicated nature of these actions was well shown in the results I obtained with three pith disks, the first being plain white, the second lampblacked on the front, and the third lamblacked on the back. The first was repelled with a power of 17·7, the second, which was the standard, with a power of 100, whilst the third was not moved at all. The repulsion exerted on the white surface must have been the same in each case, but the pressure *behind* the pith caused a radiation of heat from the back surface, which produced molecular pressure just sufficient to neutralise the pressure in front.

To show that physical condition has more effect in causing repulsion than chemical composition, I experimented with various kinds of charcoal. I found that the repulsion suffered by cocoa-nut shell charcoal is much less than that of white pith, being only 11·6 against 17·7. At the same time a radiometer made of cocoa-nut shell charcoal, lampblacked on one side, was only moderately sensitive, instead of being superior to one made of pith lampblacked on one side. The low figure shown by the charcoal was caused by its density enabling it to conduct heat from one surface to the other. Molecular pressure is therefore generated on both the back and front surfaces, and the figure I obtained is simply the difference between the two opposing actions.

I used other screens, besides water, to filter the radiation of the candle before it fell on the disk. I, however, preferred water. It is almost perfectly opaque to the invisible heat rays, and therefore its employment allows easy discrimination between actions due to heat and to heat and light combined; secondly, it is colourless, and having no selective action on any visible ray of light, it can be used in conjunction with any coloured powder without complicating the results. Alum acts in a similar manner to water; coloured solutions act as water with a super-added action due to their colour. Very thick plates of glass have less action on the invisible heat rays than a thin layer of water. Sulphate of copper, in a solution so weak as to appear only slightly green, has a very strong action when artificial light is used, as it cuts off the lowest visible red rays as well as the ultra red.

I found that the substances I had experimented on might be divided into two classes.

1. *Negative*, those in which the repulsion behind water is *greater* in proportion to the standard than when no screen is present.

2. *Positive*, those in which the repulsion in proportion to the standard is *less* behind water than when no screen is present.

Amongst Class 1 may be mentioned copper tungstate, saffranin, scarlet selenium, and copper oxalate; these are more affected by light than by invisible heat. Amongst Class 2 I may mention pale green chromic oxide, persulphocyanogen, hydrated zinc oxide, barium sulphate, and calcium carbonate; these substances are more acted on by the ultra-red rays than by the luminous rays. To render these differences of action more comparable, I divided the averages obtained by the water

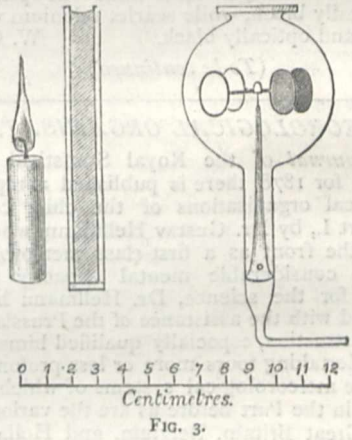

FIG. 3.

screen by twelve. Uniting the two classes together, the figures then became as follows:—

	No screen.	Water screen interposed (5 millims.)
Lampblack (standard disk) ...	100·0	8·3
Chromic oxide, pale green ...	71·5	1·7
Copper tungstate	51·2	6·4
Persulpho-cyanogen	43·9	1·0
Saffranin	41·0	4·3
Hydrated zinc oxide	40·5	1·2
Barium sulphate...	37·4	0·3
Selenium, precipitated	35·8	5·8
Copper oxalate	30·1	3·3
Calcium carbonate	28·5	0·3

An examination of this table shows that the results can be proved by balancing one powder against another in a radiometer. A bulb was therefore blown on the end of a wide tube, as shown at Fig. 3. The top of the bulb was opened and turned over to form a lip; this was ground smooth and polished, so as to be readily closed by cementing on it a piece of plate glass. A glass stem supports a fine needle in the centre of the bulb, and on this rests a glass cap, to which is attached four radial arms of aluminium. To these arms disks of mica or pith can be fastened so as to form the movable fly of a radiometer. The disks can be changed by uncementing the glass top, and lifting the fly

out with tweezers. The lower part of the tube is drawn out for connection with the mercury pump. The powders used for experiment were carefully painted on the opposite sides of pith or mica disks, only water or alcohol being used.

Disks coated on alternate sides with chromic oxide and precipitated selenium move in one direction to the naked flame of a candle, and in the other direction when a water screen is interposed. With saffranin and hydrated zinc oxide the instrument does not move at all when exposed to the naked flame, but revolves when a water screen is interposed. With thallic oxide and Magnus's green platinum salt, the instrument moves strongly when no screen is interposed, but is stopped with a water screen. These results are all in conformity with the figures.

A pith radiometer coated with precipitated selenium and chromic oxide was exposed to the radiation from a colourless gas flame from a Bunsen burner, coloured intensely green by thallium. To the eye, by this light, the chromic oxide looked nearly white, and the selenium black. The rotation due to the repulsion of the chromic oxide was, however, apparently as strong as when the non-luminous flame was used. This experiment proves that certain substances have an opposite absorptive action on rays of dark heat to what they have on light, and that an optically white body may be thermically black, and *vice versâ*. In this case, for instance, chromic oxide was optically green, and thermically black, while scarlet selenium was thermically white and optically black. W. CROOKES

(*To be continued*)

METEOROLOGICAL ORGANISATIONS

IN the *Journal* of the Royal Statistical Bureau of Prussia for 1878, there is published a report on the meteorological organisations of the chief countries of Europe, Part I., by Dr. Gustav Hellmann, who is rapidly coming to the front as a first-class meteorologist. In addition to considerable mental capacity and much enthusiasm for the science, Dr. Hellmann has, at the instance, and with the assistance of the Prussian Minister of Public Instruction, especially qualified himself for the work by undertaking tours more or less prolonged, in the countries the meteorological systems of which he reports on. These in the Part before us are the various systems in France, Great Britain, Belgium, and Holland. With the aid of a renewed grant he sets out on a second tour, this time through northern Europe, especially Russia, for the purpose of presenting similar reports on the meteorology of these countries. This action on the part of the Prussian Government has been taken, in view of a contemplated reorganisation of its meteorological system, so that when the time comes, the system may be established, not at haphazard, but on a sure basis, founded on the fullest knowledge of the requirements of the science, and on the best means to be adopted for its healthy development.

The Weather Telegraph systems of France, Great Britain, Belgium, and Holland, are fully detailed, very special attention being given to the weather warnings of France, carried out for the benefit of agriculture and horticulture. This system of weather warnings, which is so peculiarly adapted to the wants of Germany, was, as our readers are aware, the last gift to meteorology of the great Leverrier, to whom, in its practical bearings, meteorology stands so deeply indebted.

As regards France, meteorology would appear to have a most hopeful future before it, as evidenced by the mental activity brought to bear on the science, the fertility of resource in devising new methods and subjects of observation, the breadth of view shown in making the study of weather and climate subserve great public interests, and withal by the pecuniary assistance liberally and heartily given by Government and other bodies intrusted with the public funds, to the observatories, societies, and associations in various parts of France that are doing its meteorological work. Among the more special work France is doing may be noticed the application of the electric thermometer to the observation of the temperature of the air at great heights and of the soil at great depths; the establishment of several stations in Paris for the investigation of the chemistry and micrography of the atmosphere in their relations to the health of the city; and the establishment of high-level stations, which has been done largely through assistance given from the public purse.

We note with the liveliest satisfaction the great increase of meteorological stations over these four countries, the introduction of instruments for continuous observations in regions where they were much required, and a more adequate observation of the rainfall, particularly in the British Isles, where about 2,100 rain-gauges are at work, and in the river-basins of France, where the rainfall is noted at 1,111 stations.

Forcible attention is directed to the fact that in some cases the reduction of the observations and publication of the results are not carried out, or carried out very imperfectly, so that no little difficulty is experienced when conducting climatological inquiries, in obtaining the data from considerable portions of Western Europe. This defect ought to be rectified without delay.

Reference is made to international stations, or stations at which observations are made for purposes of international meteorology. But on looking at the diverse hours of observation adopted by the different European systems, it is evident that the attempt recently made to found an international meteorology must be regarded as a failure, since the prime and most elementary condition of uniformity as regards hours of observation has been neglected, the just views on this vital point propounded by Humboldt and the meteorologists of his time being at present, if appreciated, entirely set aside.

MYCOLOGY[1]

IT is perhaps not generally known how very numerous are the specimens comprised under the branch Mycology. The mycological herbarium which is in the course of transmission to Kew consists of at least 10,000 species, of which 7,500, comprising the Hymenomycetes and Ascomycetes, have already been forwarded. But not only are many species very beautiful in form and colour, but the subject is one of great interest both in a physiological and economical point of view, apart from mere distinction of species and nomenclature, and, therefore, while especial journals are devoted to entomology, malacology, algology, and other branches of natural history, it is quite right that we should have one devoted to fungi. M. Roumeguère ought, however, to have mentioned that England already possesses one in Grevillea quite equal to the French journal, which has appeared with great regularity ever since 1872, and is monthly instead of trimestrial, of the existence of which he could scarcely be ignorant, as it is referred to more than once in the number before us.

The Journal before us commences with a paper on the much-vexed question of the real nature of lichens, in which the author is altogether opposed to Schwendener's theory of their parasitic growth on Algæ. There are two points which ought to be noticed: that the growth of Gonidia from Hyphæ was observed by Mr. Berkeley, as recorded in the "Introduction to Cryptogamic Botany,"[2] while the stem of the curious

[1] "Revue Mycologique: Recueil trimestriel consacré à l'Étude des Champignons." Par M. C. Roumeguère. (Paris: J. B. Baillière et Fils.)
[2] "Int. Crypt. Bot.," p. 373, Fig. 78*a*.
[3] "Int. Crypt. Bot.," p. 341, Fig. 76.

genus, *Emericella*,[3] a Lycoperdoid, is composed of bodies which closely resemble *Palmella botryoides*, Grev. The fungus was found on the leaves of *Euphorbia neriifolia*, in the hot country of Secunderabad, a very unlikely locality for a *Palmella*. Though the observations in the paper are not absolutely convincing, they are highly worthy of consideration, and may induce the advocates of the theory of Schwendener to reconsider the matter and make fresh experiments.

The other papers in the number do not require any especial consideration, though it may at once be allowed that they contain much matter of interest, scarcely, however, so much as regards physiology as might have been wished, for that, after all, is the point which is most likely to engage general interest. It is very unfortunate that the Tulasnes, after doing so much for mycology, have of late retired almost entirely from their former line of study. It is impossible to give too much credit to the result of their researches, or the admirable drawings with which they are abundantly illustrated. There are, however, other labourers in the field who are carrying on their work, amongst whom it is impossible to neglect De Bary, even when such observations as those on the development of *Ascobolus* may require confirmation. They are too curious and important to be set aside without fresh examination, and whatever views may prevail as to the nature of lichens, it is so certain that they are essentially fungals, that the origin of the fructification must be the same, or at least analogous. Much remains to be done as to the impregnation of the English fungi, for Mr. W. Smith's ingenious paper on the fructification of *Agaricus lacrymabundus* cannot at present be received as more than a mere speculation. De Bary's observations on the supposed occurrence of asci in *Agaricus melleus* are confessedly due to the presence of a parasitic Hypomyces. M. Cornu, however, is attending to this as to many other objects of interest; while van Tieghem is adding daily to our knowledge of the different kinds of *Mucedines*, and Drs. Cunningham and Lewis are working effectively in India. It is to be regretted that Mr. Renny has never published the numerous new genera he has figured in this department, which vie, for beauty and singularity, with anything which has been recorded by van Tieghem. Mr. Abbay has lately made some curious observations on the germination of the spores of *Hemileia*, which is so destructive in the coffee plantations of Ceylon. He does not, however, seem to be aware, that Mr. Thwaites had already observed that the species in germinating always produce a Penicillium, though Mr. Abbay has much extended his observations.

Brefeld and Rees have made many valuable observations with respect to the production of asci with sporidia in yeast. Rees, however, states that under the most advantageous conditions he has never been able to induce the globules to send out threads of mycelium. This was, however, done by Mr. Hoffman, of Margate, the account of whose observations, in company with the author of the present notice, are recorded in the article "Yeast," in the "Cyclopædia of Agriculture," the same manipulation showing that the Sclerotium of onions is a condition of a minute Mucor. Their success depended upon having the disk of water in which a very limited number of yeast globules were inclosed, being surrounded in a sealed cell with an atmosphere of air.

These observations should not be closed without a notice of Woronin's very complete observations on the disease commonly known as the club in cabbages. He not only succeeded in discovering the fungus to which it is due, but was enabled to complete his experiments by its actual cultivation. The figures which accompany his memoir are beyond all praise. We may expect more from his hand on these obscure productions. The genus *Protomyces* will probably afford some unexpected results, and we may yet hope for something more satisfactory on the nature of the bodies which are so common on the roots of Leguminosæ.

Finally, M. Cornu's researches in the Saprolegniæ have increased our knowledge of these curious organisms, most authorities being now of opinion that they are aquatic fungi; while many other valuable communications, of almost equal interest, are necessarily omitted.

M. J. BERKELEY

GEOGRAPHICAL NOTES

THE April number of the Geographical Society's new periodical contains Mr. Comber's paper on his explorations inland from Mount Cameroons, and his journey through Congo to Makuta, the late Capt. Patterson's notes on the Bamangwate country, South Africa, and Gen. Kaye's paper on the mountain passes leading to the Valley of Bamian, all of which were read at recent meetings. These are followed by some remarks on the colouring of maps, by Prof. Cayley, the Council's memorial respecting professorships of geography, &c. The geographical notes contain several items of interest. In one are some useful explanatory remarks respecting Major Pinto's reported "solution of the Cubango mystery," while another fixes the locality of Lake Chaia (not marked on any of our maps) near which Lieut. Wauthier died and Mr. Penrose was murdered. There are also same particulars respecting Japanese colonisation in the Island of Yesso, and Mr. Alex. Forrest's expedition to explore and survey the unknown tract of country between the De Grey and Victoria rivers in North-western Australia. The present number is illustrated by two maps, the one of Mount Cameroons and the neighbouring country, from a drawing by Mr. Comber, and the other of the Bamangwate country, also from new material.

THE *Globe* gives the following as the official programme that has been drawn up for the "Imperial Expedition" to Central Asia, under the command of the Grand Duke Nicholas Constantinovitch. The staff of the expedition will be an engineer from the Ministry of Railways, an officer of the Baltic fleet, a surveyor, a naturalist, an archæologist, a geologist, a painter, a correspondent, and a topographer. The aim of the expedition is to select the route of the Central Asian Railway, to examine the navigability of the Oxus, and to decide the possibility of diverting it into the Caspian. The route will be from the River Ural to Karasugai, on the Syr Daria, thence *viâ* Tashkend and Samarcand to the Oxus at Kunduz (Afghanistan); afterwards along the river to Khiva, and across the Kara Kum to Krasnovodsk. The work of the expedition will be: 1. To collect information as to the cost of the railway, the ability to obtain materials for its construction, whether fuel exists on the route, and the amount of labour obtainable. 2. To investigate the speed of the Oxus, the height of its banks, the population of the nearest towns and settlements, and the existing commerce on the river. 3. To examine the Khiva oasis, the floods of Sari Kamish, and the ancient bed of the Oxus, commonly known as the Uzboc. 4. To carry out astronomical observations all the way along the route, to make military plans, to sketch the features of the country, to collect objects of mineralogical, zoological, geological, and archæological interest, and to keep a journal of daily events. Finally, in collecting information respecting the ancient course of the Oxus, to decide whether it can be diverted afresh into the Caspian without detriment to the Khivan oasis. It seems possible, however, that in case of certain Eastern complications the expedition may develop into a military one against Merv.

FURTHER news has been received from Dr. Crevaux, the explorer of French Guiana. He returned to Guiana about the middle of last year for the purpose of exploring

the Oyapok, the second river of the colony, the basin of which was comparatively unknown. On August 21 Dr. Crevaux was at the mouth of the river. Crossing a second time the Tumuc-Humac range, which separates the waters of the Oyapok and Maroni from those of the Amazon, he descended the Kou, an affluent of the Yari, the course of which was unknown. Arrived at the Yari, which on a former occasion he had ascended only as far as Yacouman, he followed its course to its sources, which he reached on October 24 last, after a journey of about 170 miles on that river. On that date he wrote a note in pencil to Paris, announcing the result of that part of his journey, but predicting for the remainder of his exploration considerable difficulties, which, however, he has succeeded in surmounting. A short letter just received by *La Nature* intimates the return of Dr. Crevaux to Sainte Marie de Belem on January 9 last, and contains a topographical sketch of the region explored. After having crossed the secondary chain which separates on the west the Yari from the Parou, another almost unknown affluent of the Amazon, Dr. Crevaux completely explored this considerable watercourse, and afterwards, descending the river, he re-explored the lower course of the Yari.

A TELEGRAM addressed by Gordon Pasha from Abujerad, on the White Nile, to the president of the Italian Geographical Society, announces that Signor Matteucci, the leader of the Italian scientific expedition, having received permission to enter Abyssinia, had started from Adowa and landed at Massowah.

THE French traveller, M. le Comte de Semellé, arrived at Fernando Po on February 13 from the Upper Niger and Binué. He started on his expedition in May of last year, and had been engaged in pursuing his researches up to the time he returned to Fernando Po. He has forwarded to England and France an account of some of his discoveries.

THERE seems every likelihood that an attempt will be made to train African elephants as bearers of burdens, and indeed it is stated that an association has been formed for the opening up of African trade by this means. This seems to us a much more sensible and practicable plan than the construction of a railway, which has been so prematurely proposed in some quarters. With the aid at first of Indian trainers we see no reason why the African elephant should not be made as useful as his Indian brother.

THE intended laying of a telegraphic line from Aden to Zanzibar, and from Zanzibar to Port Natal *viâ* Mozambique and Delagoa Bay has promoted a project for connecting the Mascarene Islands either with Zanzibar by the Comoros or with Delagoa Bay through Madagascar by a special line. It is said that the general council of Reunion will take the lead. The aggregate population of the Mauritius and Reunion is more than half a million, and the trade of these two islands with Europe reaches annually a large sum. The density of population is very great.

MGR. LAVIGERIE, Archbishop of Algiers, has informed *Les Missions Catholiques* that it is in contemplation to increase the staff of the French Algerian Missionary expedition in Central Africa to ten priests, one of whom is to found a depot in the neighbourhood of Zanzibar for the missions of the interior.

WE gather from the *Colonies and India* that some interesting papers have appeared in the Ceylon press relative to the suitability of that island for the growth of Australian trees. The blue gum-tree does not seem to flourish under an elevation of 3,000 feet. The *Casuarina* grows freely even by the seashore. The *Grevillea robusta*, one of the most beautiful and most useful of Australian trees, had thriven well in Colombo itself, though it will not stand the full force of the sea breezes.

THE steam traffic in the Indian Archipelago has so largely increased since the opening of the Suez Canal that the roads of Batavia are found insufficient for the accommodation of the vessels, and the Netherlands Government have accordingly found it necessary to undertake the construction of a new port. This, we learn from the Manila papers, is situated in Cape Tanjong Priok, to the east of Batavia, and is to have communication with that city by means of a canal and a railway. The work of construction was commenced in 1877, and 3,000 men are at present employed on it. The new port, which is to be named after Prince Henry, will, it is expected, be finished in 1885.

THE last number of *Le Globe* contains the first instalment of a sketch by M. Veniukof of geographical discoveries in Asiatic Russia, translated by M. Metchnikof.

THE French Alpine Club has organised a tour for school boys for the Easter holidays. The excursionists will travel on foot in the two departments of Loiret and Loir et Cher, visiting Orleans forest, the banks of the Loire, Chambord Castle, and the forest of Fontainebleau, where the last frosty weather produced such extraordinary disorders. The regulations will be sent on request to the Secretaire-General of the Alpine Club, 31, rue Bonaparte, Paris. No limit of nationality is imposed. The excursion will last for seven days and be conducted by a staff of competent teachers.

A SPECIAL congress on the means of creating an interoceanic canal across the Darien Isthmus will be opened shortly by the Society of Commercial Geography of Paris.

BY a census taken in December last it appears that the population of Japan now numbers 34,338,304 souls. Yedo, which at one time had the reputation of being the most populous city in the world, contains 1,036,771 inhabitants and 236,961 houses.

NOTES

THE Copernican Society at Thorn has resolved to begin an international collection of funds for the erection of an observatory in that town, as a lasting monument to the great reformer of astronomy.

M. BAILLAUD, Professor of Astronomy to the Faculty of Sciences of Toulouse, has been appointed director for five years of the observatory of that city.

THE anniversary meeting of the Chemical Society was held on Monday, Dr. Gladstone, F.R.S., president, in the chair. The President presented his Annual Report on the state of the Society, which he characterised as affording ground for congratulation, the past year having been one of quiet prosperity. The Society numbers now over 1,000 members. Sixty-eight papers have been read and two lectures delivered by H. C. Sorby and S. H. Vines; the Faraday Lecture was delivered by Prof. Wurtz. The improved condition of the Society's library and journal was touched upon. In conclusion, the President urged the Fellows not to rest satisfied with the present attainments of the Society, but to promote research, and especially a general scientific culture in the workers, a culture which should promote largeness of view and prevent each investigator looking on his own subject as one of prime importance, to the exclusion of all others. The Report of the Research Fund Committee was then read, with a brief account of the investigations carried on in connection with the fund. After the customary vote of thanks to the officers, council, &c., the following officers and council were elected for the ensuing year:—President—Warren De La Rue, F.R.S. Vice-presidents—F. A. Abel, C.B., Sir B. C. Brodie, E. Frankland,

J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, A. W. Williamson, F. Field, J. H. Gilbert, N. S. Maskelyne, H. E. Roscoe, R. Angus Smith, J. Young. Secretaries—W. H. Perkin and H. E. Armstrong. Foreign Secretary—Hugo Müller. Treasurer—W. J. Russell. Other Members of Council—M. Carteighe, A. H. Church, W. H. Bartley, C. W. Heaton, E. Riley, W. C. Roberts, W. A. Tilden, W. Thorp, T. E. Thorpe, J. L. W. Thudichum, R. V. Tuson, R. Warington.

THE eminent algologist Dr. Rabenhorst has been compelled, in consequence of continued ill-health, to resign the editorship of the monthly cryptogamic journal *Hedwigia;* and it has now passed into the hands of Dr. G. Winter of Zürich, well known for his contributions to various departments of cryptogamic literature.

THE *Library Bulletin* of Harvard University is a publication much more interesting and valuable than its title would seem to imply. It is edited by the librarian, Mr. Justin Winsor, one of the greatest living authorities in all matters connected with libraries. We have before us No. 10 of the *Bulletin*, containing first of all a list of the more important accessions to the library between October 1878 and January 1879. This is a model list, and several of the entries are really elaborate essays, as that under the heading Maps, on Early Globes. The supplement to this list is devoted to articles, some of them of great scientific value. For example, under the title of "References in Analytic Geometry," we are furnished with a minute analysis of Descartes' Geometry. Prof. Goodall, under the title of "Floras of Different Countries" gives bibliographies of the Floras of Africa and America. In the supplement there is much other bibliographical material of literary and artistic value, each subject being continued in the supplements of successive *Bulletins*, until completed. Mr. Winsor intimates that he is preparing a list of all editions of Ptolemy's Geography, and desires detailed information of any editions that may be in foreign libraries. Altogether this *Bulletin* is one of the most valuable bibliographical publications we know of.

THE death is announced of Prof. Karmarsch, the well-known technologist. He was born in 1803. In 1823, when he was twenty years of age, appeared his first work, and his labours ended in 1872 with the publication of his greatly-valued "History of Technology." He was long director of the Hanover Polytechnic School, which was founded under his superintendence. He retired from active life in 1875.

THE French Minister of Public Works has given the required authorisation to M. Gaston Tissandier to establish Giffard's balloon in the Cours des Tuileries, and the works are progressing with great activity. The ascents are to begin on the first days of May, the price is to be reduced to 10 francs, and the admission fee for spectators to 50 centimes.

THE *Daily News* New York correspondent telegraphs that Mr. Edison has exhibited the working of his incandescent light in the illumination of his laboratory and factory, with excellent results, furnishing fourteen of the new lamps each from 18 to 20 candle power, on one circuit, giving a steady white light, much superior to the carbon, and equal to double the number of gas-jets. The generator was an ordinary Gramme machine of 2½-horse power. Mr. Edison states that he can now supply light for practical domestic use at less than half the cost of gas, but is experimenting for further improvements in the lamp and economy in the generator. He has discovered a new alloy, platinum and iridium, by the use of which he increases the number of lamps per horse power at least 50 per cent.

THE April number of *Mind* contains a paper of much interest by Mr. G. Stanley Hall on Laura Bridgman, the much-written-about American girl, who at an early age was deprived of nearly all her senses but that of touch; the paper is the result of a recent visit to Laura. Prof. Bain commences a series of papers on the life and character of John Stuart Mill.

THERE is a short and interesting article in the *Sanitary Record* of March 28 on the Registrar-General's method of estimating populations. It shows that the true method is not to take the average rate of increase during any decade to ascertain the increment of the following decade. The true rate of increase is obtained by the difference between the logarithms of any two decades.

THE number of lights for electric light-houses in France is to be increased by two important constructions, one on Planier Isle, off Marseilles, and the other at the mouth of the Gironde. There are at present in existence in France only three, one at Cape Grisnez and two at Cape La Heve, off Havre. These lighthouses are supplied with Alliance electro-magnetic engines.

THE session of the delegates of the Sociétés Savantes will be begun as usual at the Sorbonne after Easter, and M. Ferry will deliver an address on the occasion of the distribution of prizes.

A STRIKING and highly promising line of research has been recently adopted by Mr. Muybridge, of San Francisco, at the instance of Governor Stanford, viz., the instantaneous photography of animals in motion. Some of his earlier photographs of a fast-trotting horse presented attitudes wholly unexpected, and they were even thought absurd. The method latterly adopted seems to have been making the horse trot or gallop past twelve cameras, arranged in series, and by breaking threads stretched across its path, release an electric current, which effected exposure of the plates. Thus the flying steed was obtained in every position. Mr. Muybridge gave public exhibitions of what had been done. The small negatives were magnified into life size, and projected on a screen, so that every motion was visible. These exhibitions do not seem to have been appreciated by the San Franciscans. The *Scientific American*, however, and afterwards *La Nature*, have published cuts taken from the photographs, and much general interest has been awakened in these researches. Among those specially interested is Prof. Marey, who desired to be put in communication with Mr. Muybridge, as he wanted to ask his aid in solving certain physiological problems, so difficult to solve otherwise; *e.g.*, questions connected with the flight of birds. He had been dreaming of a kind of photographic gun, to seize the bird in an attitude or series of attitudes of flight. What beautiful zootropes, too, might be had! Mr. Muybridge's cartoons representing the fast gallop give a key to the breaking down of so many horses. It appears as though one fore-leg had to sustain the whole of the weight of horse and rider while the body is moved along five feet. And just before the foot is raised, a perpendicular from it would strike the back of the saddle; so that there is immense leverage, the centre of gravity being thrown so far forward of its support, and the tendons must have a terrible tension. These inquiries are being further developed by the liberality of Governor Stanford and the skill of Mr. Muybridge, and valuable results may doubtless be looked for.

AMONG recent lectures delivered at the Sorbonne was one by Prof. Marey, who has so admirably applied the graphic method in physiology. His subject was the circulation of the blood, and though (the auditory containing ladies) experiments involving the presentation of blood were naturally proscribed, he was able to give several striking demonstrations. One of these consisted in showing on an illuminated surface the phases of the heart beats of his assistant's and his own pulse, the beats being transmitted across the hall, by a thin tube, the pulsations actuating a small inscribing style placed before the electric lamp. He also exhi-

bited a number of his ingenious apparatus illustrating the circulation, working them with water.

THE "Sixth Annual Report" of the Michigan State Board of Health is of much more than local interest. The Board seems to be a body who have a very thorough and comprehensive idea of their duty, which is very faithfully carried out by their secretary, Mr. H. B. Baker. The Report contains inquiries into all sorts of subjects connected with the sanitary condition of the people of Michigan, and many of the results obtained are of general interest. For example, with regard to earthen vessels used for domestic purposes, we are told that to the glazing material used for the inside the oxide of lead is sometimes added, making, with the alkaline silicates, borates, &c., a very fusible and closely adhering glazing. But its use is very dangerous, especially if the vessel contains acid substances, such as pickles with vinegar; the glazing decomposes, and lead salts form, which either dissolve or become mechanically suspended in the contents of the jar, and there is great danger of chronic lead-poisoning. The Report also contains some useful remarks on the various substances used to enamel iron vessels. There is also a very careful study of the climate and topography of the lower peninsula of Michigan, the meteorology of Michigan for 1877, and other information of much value.

A NEW form of water-level indicator, we learn from the Society of Arts *Journal*, has lately been designed and constructed by the India-rubber, Gutta-percha, and Telegraph Works Company, Silvertown, and has been erected by them at the Leamington New Water-Works, where it is stated to be giving every satisfaction. The reservoirs from which the supply of water is distributed to the town are situated some half-mile from the pumping-station, and it was therefore found necessary to have some kind of indicator placed at the engine-house, in order to enable the man in charge of the engines to see at a glance the exact height at which the water stood in the reservoir, so that he might be able to regulate the rate of pumping accordingly. The indicator that has been placed at the engine-houses resembles somewhat, in outward appearance an ordinary round metal case clock; the dial, instead of being divided into hours, minutes, &c., is divided into twenty equal divisions representing feet, and corresponding to the rise and fall that is required to be registered. A hand on the dial points to one of the divisions, which at any particular instant corresponds to the height at which the water in the reservoir stands. This hand, for every foot rise in the level of the water, moves an equal number of divisions round the dial; whilst, as the water falls, the hand turns back in the other direction, so that it always points to the exact height at which the water stands in the reservoir. A single line of ordinary telegraph wire communicates between the indicator and the apparatus at the reservoir. This apparatus is so constructed that at every foot rise of the water one pole of a battery is brought into connection with the line for a certain space of time, and the current from the the battery actuating the indicator at the engine-house, causes the hand to move the requisite distance round the dial. On, however, the water falling, the opposite pole of the battery is brought into connection with the line, and this is made to cause the indicator hand to move in a contrary direction. The apparatus at the reservoir is actuated by an ordinary float and weight in the water, and is arranged in such a manner that the battery contacts are always of the same duration, irrespective of the rate at which the water may be either rising or falling. A variety of uses will at once suggest themselves to which this class of electric indicator might be advantageously applied, as it can be arranged, if required, to give a diagram on paper of the water level at stated intervals of times, instead of using a hand to point to the divisions on the dial, as in the present instance; also it is evident that it can quite as readily be made to give variations in inches as in feet. As a tide indicator it might be made very serviceable on many of our large rivers, and probably ere long we shall hear of some further uses to which this novel application of electricity has been applied.

A SHOCK of earthquake was felt at Hetzdorf and Oederan, Saxony, in the night from March 12 to 13. The shock had a north-westerly direction, and a violent storm was raging at the time. At Hall, in the Tyrol, a violent shock was felt on March 13, at 11.15 P.M., in the direction from west to east.

THE *Report* of the Glasgow Industrial Museum for 1878 is satisfactory, showing as it does that the institution, under the care of Mr. Paton, is in a fair way of developing into something worthy of a city of the first commercial importance.

WE have received a copy of the Hunterian Oration delivered at the Royal College of Surgeons on February 14 last, by Prof. Humphry. It is published by Macmillan and Co.

THE Spanish *Crónica Científica* of March 25 contains among other interesting papers a Catalogue of the Terrestrial Testaceous Molluscs of the plain of Barcelona.

PART I. has been sent us of "A Universal Dictionary for Architects, Civil Engineers, Surveyors, Sculptors, Archæologists," &c., &c., by Mr. W. J. Christy. The London publishers are Griffith and Farran.

PROF. VIRCHOW has left Berlin for Troy in acceptance of an invitation from Dr. Schliemann.

BULLETIN No. 1 of vol. v. of the United States Geological Survey of the Territories, contains the following papers:—Notes on the Aphididæ of the United States, with descriptions of species occurring west of the Mississippi, by Chas. V. Riley and J. Monell; The relations of the horizons of extinct vertebrata of Europe and North America, by E. D. Cope; Observations on the faunæ of the miocene tertiaries of Oregon, by E. D. Cope; Notes on the birds of Fort Sisseton, Dakota Territory, by Chas. E. McChesney, Acting Assistant Surgeon, U.S.A.; Palæontological papers, No. 9: Fossils of the Jura-Trias of South-Eastern Idaho, by C. A. White, M.D.; Jura-Trias Section of South-Eastern Idaho and Western Wyoming, by A. C. Peale, M.D.; Fossil forests of the volcanic tertiary formations of the Yellowstone National Park, by W. H. Holmes; Palæontological papers, No. 10: Conditions of preservation of invertebrate fossils, by C. A. White; Supplement to the bibliography of North American invertebrate palæontology, by C. A. White and H. Alleyne Nicholson.

DR. C. V. RILEY has reprinted in a separate form the entomological papers contributed by him to the last meeting of the American Association for the Advancement of Science. They are: "The Philosophy of the Movements of the Rocky Mountain Locust," "A New Source of Wealth to the United States," "Notes on the Life-History of the Blister Beetles and on the Structure and Development of Hornia," "On the Larval Characteristics of Corydalus and Chauliodes, and on the Development of *Corydalus cornutus*," Biological Notes on the Gall-making Pemphigmæ."

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. J. N. T. Martheze; a Globose Curassow (*Crax globicera*) from South America, presented by the Rev. Ralph Cooper; a Grey-breasted Parrakeet (*Bolborhynchus monachus*) from Paraguay, presented by Miss Maria Hilhouse; a Common Peafowl (*Pavo muticus*) from India, presented by Mr. F. B. Hopkinson; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. F.

Belcher; five European Geckos (*Phyllodactylus europæus*) from Italy, presented by Prof. H. H. Giglioli, C.M.Z.S.; a Cape Ant-bear (*Orycheropus capensis*) from South Africa, purchased.

INTELLECT IN BRUTES

WE have another batch of letters on this subject, the essential points of which we shall endeavour to give in brief space:—

Mr. Wm. Hogg tells us of an incident he witnessed when calling on Mr. W. H. Michael, a gentleman well known at the parliamentary bar, who resides at Queen Anne's Gate, St. James's Park. While they were sitting in the study, the French window of which communicates with a garden at the back of the house, and had a crank latch by which it could be opened on either side, a cat presented herself outside the window, pleading for admission. She continued to plead for some time, and finding no help from within she resolved to trust to her own powers. Eying the latch, which was four feet above her, she made a spring, caught hold of the crank with her fore feet, and putting her hind feet against the other half of the window as a fulcrum she pressed open the window. This she would do several times in succession. Mr. Michael informed Mr. Hogg that the cat had never been taught to do this.

D. R. S. sends the story of a little terrier that left her puppies only once a day to be fed, gulping down hurriedly a great quantity of porridge. Returning quickly to her family she would put up all the porridge in order that she and her puppies might together enjoy a hearty meal. When the terrier was scolded for a fault it rushed away to a little distance and catching up anything it could get hold of at once—a bit of stick, a straw, a slipper or anything at hand—it would come coweringly and lay it down at our feet, with an expression of utter submission. If we were not propitiated it would run off a second time and bring another peace-offering, often in its distress catching things it would not at any other time have dared to touch.

M. W. T. writes:—A farmer, in Somersetshire, was going to a neighbouring village some three miles distant, and, not wishing to take his dog he ordered him home. The dog reluctantly obeyed. When the man arrived at a spot, about half way on his road, where the short cut he had taken across the fields joined the more circuitous road, he found the dog waiting for him. Evidently the animal had taken the longer route, which he doubtless knew, calculating on meeting his master at that point, and thus gaining his end without hindrance.

Mr. John Harmer, of Wick, Arundel, possessed a few years ago a very fine and intelligent tom-cat which was much addicted to plundering a rabbit-warren about a mile from his home. After a time it was noticed that before he proceeded on one of his expeditions "Sam" completed his toilet by wallowing in the filth turned out of the tame rabbits' hutches, he taking particular care that his neck and breast should be in as disgusting a condition as possible by smearing them up and down till both were saturated and the fur all matted together.

Mr. J. J. Cole of Mayland, Sutton, Surrey, writes:—It has been my custom to have—not a letter-box in a door in the usual way but the plate and flap in the bottom of a window sash near. I had a cat which often saw a servant go to the window on hearing the flap moved by the postman, and which, when shut out used to jump on to the window sill and rattle the flap and when the servant was seen through the glass jump down to be let in at the door. I knew a horse which during week days went round and round to the left, grinding in the cellar of a snuff maker in London. On Sundays his owner turned him out in a field at his place in the country where the horse went round and round all day long unwinding himself the other way. Why?

Mr. B. G. Jenkins describes a scene he witnessed between the large insect known as "daddy long-legs" and a small spider. The former got caught by one of its hind-legs by a pendant thread of cobweb about eight inches long, at the other end of which was the small spider. The spider cautiously descended on the thread, doubling it as he came, and secured the insect's leg more firmly. He then ascended about three inches, and drew the insect up about half an inch; but a violent resistance on the part of the latter induced him to give up the attempt. He, however, went up the thread, strengthening it as he went, and coming down again to the same place, evidently attempted once more to raise his prey, but without success, for the insect resisted so stoutly that it appeared to me to stretch the thread. The spider, Mr. Jenkins writes, saw clearly that the insect was too strong for him, that he would never be able to draw him up to the centre of his web, and that if he did not take very summary measures he would lose him altogether; so, on the principle that half a loaf is better than no bread, he set to work to secure a portion of it. The hind-leg of the insect, to which he had his web fastened, was composed of four jointed portions. Round three of these he busied himself weaving a web. Mr. Jenkins noticed particularly that he did not go up to the last jointed portion, that attached to the body. Having well secured these three, he moved up to the joint, and for a few moments appeared perfectly still. Suddenly the insect darted away, leaving three-quarters of its leg behind. What other explanation is there than that the spider disconnected it at the joint? Quietly ascending the thread, which he carried with him, and of course the leg as well, he properly placed the latter, settled down at the union of the two uppermost portions, gorged himself with juices from above and below, and then retired for the night.

Several correspondents express surprise at Mr. Henslow's position with regard to "abstract" and "practical" reasoning. They think that several of the instances adduced render that position untenable, and prove that in their degree the animals referred to showed themselves possessed of powers of "abstract" reasoning. With regard to the dog and bell story, Dr. Rae writes:—It was never intended to be understood that the dog associated the bell with "a *particular* maid," as Mr. Henslow puts it; any of the other servants would have done equally well. The dog could only show his reasoning powers by declining to ring the bell; for had he rung it, Mr. Henslow or any one else would naturally have said that the "brute" had shown no reasoning powers at all. Mr. Henslow has passed over without notice the fox and gun story, which, by his own definition, was as clearly a case of abstract reasoning as could be adduced, differing only in form of carrying into effect from what he would have recommended, which, if adopted by the fox, would have led to its destruction.

Dr. G. Frost sends the following good story:—

In answer to Mr. Henslow's request for an example of "abstract reasoning" in the lower animals (NATURE, vol. xix. p. 433), I beg to subjoin the following:—Our servants have been accustomed during the late frost to throw the crumbs remaining from the breakfast table to the birds, and I have several times noticed that our cat used to wait there in ambush in the expectation of obtaining a hearty meal from one or two of the assembled birds. Now, so far, this circumstance in itself is not an "example of abstract reasoning." But to continue: For the last few days this practice of feeding the birds has been left off. The cat, however, with an almost incredible amount of forethought, was observed by myself, together with two other members of the household, to scatter crumbs on the grass, with the obvious intention of enticing the birds. I think Mr. Henslow might now be convinced that animals also possess in an inferior degree that boasted reasoning power which is generally supposed to belong to man alone.

THE PLANE OF POLARISATION ELECTRO-MAGNETICALLY ROTATED IN A VAPOUR

IT is known that Faraday did not succeed in proving electro-magnetic rotation of the plane of polarisation of light in gases, nor have others succeeded. Considering the interest attaching to this question, Herr Kundt and Herr Röntgen lately thought to repeat the attempt with very strong currents and under the most favourable conditions. The result is that they have been able to prove the rotation, at least in the case of sulphide of carbon vapour. (Their researches have been communicated to the Munich Academy.)

Sulphide of carbon was chosen because, on the one hand, it shows a strong electro-magnetic rotation in the liquid state, and on the other, its vapour has a considerable tension, even at low temperatures. An iron tube was used for inclosure and heating of the substance; it was closed at the two ends with glass plates 1 ctm. thick, and itself inclosed in a tin-plate tube; so that steam could be led between the tubes to heat the inner tube throughout to 100°. The outer tube was surrounded by six large wire-coils, each having 400 windings of wire 3mm. thick,

through which was passed the current from sixty-four large Bunsen elements. A little sulphide of carbon was introduced into the inner tube, and the air having been driven out by vapour forming at ordinary temperature, the tube was closed and fixed in position, and steam was sent through the space round it.

When the whole tube had taken the temperature of boiling water the glass plates and the sulphide of carbon vapour within became quite transparent. A beam of light rectilinearly polarised by a Nicol was now sent through, and a Nicol at the other end extinguished it. The current of the sixty-four elements being now allowed to flow, a distinct brightening of the field was observed. The brightening became still greater when, after closing the circuit, the foremost Nicol was turned to darkness, and the current then reversed with a commutator. The rotation of the plane of polarisation occurred, as was to be expected, in the direction in which the positive current passed through the wire coils.

To test whether the rotation might not be due wholly or in part to the glass plates closing the inner tube, the experiment was made without any sulphide of carbon in this tube. A weak rotation, due to the glass, was indeed observed, much smaller than in the other case. To avoid this, however, as much as possible, the wire coils next the glass plates were shut out from the circuit. The four coils now traversed by the current were so far from the plates that their influence must have been very small, indeed the plates then gave no perceptible rotation. Sulphide of carbon having been again admitted, and the experiment repeated, there was a well-marked brightening as before, when the current passed. The amount was roughly estimated at half a degree.

It is thus proved that saturated sulphide of carbon vapour at about 100°, *in the magnetic field, rotates the plane of polarisation of light.*

Sulphuric ether was tried in the same way, but gave no effect.

The authors consider it can hardly be doubted that, with suitable arrangements, the rotation may be demonstrated in the case of unsaturated vapours and gases. They are engaged in making an apparatus which will enable them to examine permanent gases at very high pressures in the magnetic field, in order to prove the rotation in their case, and, if possible, to measure the phenomenon. "It would be specially interesting," they remark, "to ascertain whether oxygen rotates the plane of polarisation in the same direction as other gases."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

A BROAD and liberal scheme has been published by the Cambridge Syndicate on the affiliation of local Colleges to the University as suggested in various Memorials. They have taken a large amount of evidence and have had interviews with deputations from Nottingham and Sheffield. They have also held conferences with a Committee of the Hebdomadal Council of the University of Oxford, with whom they find themselves in general agreement. The Syndicate recommend that application be made to the University of Cambridge Commissioners for the powers required to enable the University to affiliate local Colleges, and that the following conditions of affiliation be established by grace of the Senate. Any educational institution within the British dominions, in which the majority of the students are over seventeen years of age, may be admitted on condition that it be incorporated by Royal Charter, or established on a permanent and efficient footing; that the University shall be represented on its Governing Body, and undertake the general conduct of its Examinations; and that the connection between the University and an affiliated College shall be established and shall be terminable by a grace of the Senate, or by a resolution of the Governing Body of the College. Persons who have completed an approved course of three years at an affiliated College, passing satisfactorily the Examinations connected with that course, will be entitled to receive a University Certificate, and if they obtain honours in the final Examination connected with that course, shall be excused the previous Examination; and provided they obtain a degree by one of the Tripos Examinations will be permitted to take their degree after only six terms' residence at Cambridge. In each College there are to be three examinations yearly, the Annual College Examination, the First and the Second Examinations, the Annual College Examination is to be held in subjects taught with the sanction of the University, in the College, and be open to those students noly who have satisfactorily attended the teaching in these subjects. To pass the First Examination every candidate will be required to satisfy the Examiners in (1) Arithmetic; (2) Euclid, Books I., II., and III.; and Algebra, to Quadratic Equations inclusive; (3) One of the following languages: Latin, Greek, French, Italian, German. Candidates will be at liberty to take up more than one language, and one or more additional subjects, including Heat, Experimental Mechanics, Chemistry, Botany, and Mathematics. 4. The Second Examination shall include four groups: (1) Ancient and Modern Languages, two to be taken. (2) Mathematics, one higher subject, pure or applied, being required. (3) Natural Science. Candidates pass in Elementary Chemistry and Physics, and also in one of the following:—Higher Chemistry, Higher Physics, Animal and Vegetable Physiology, Comparative Anatomy with selected portions of Zoology, Vegetable Anatomy and Physiology with Classificatory Botany, Geology and Physiography, Mineralogy. Candidates to pass in (1) English Constitutional History and (2) Political Economy or Logic, and subjects connected with History, Literature, and Philosophy. A pass in one group will give a pass in this second examination, and honours may be obtained on the minimum number of subjects. The Syndicate think it desirable to avoid if possible increasing seriously the severe strain caused by the outside work of the University. The sections and groups of the senior and higher local examinations are in general correspondence with the scheme, and the lectures at the centres are under the superintendence of the Syndicate for conducting local examinations and lectures. Thus there is machinery in existence which may, with some modifications, be conveniently and properly used. It is thought desirable that the Universities of Oxford and Cambridge should, as far as practicable, act in concert in conducting this great scheme of affiliation. It is recommended that the scheme be so administered as to be self-supporting.

THE Cambridge Council of the Senate propose to repeal entirely the few unrepealed provisions in the will of Dr. Woodward relating to the Professorship of Geology, and to frame a new statute on a plan already approved for the Professorship of Chemistry. The same plan is likely to be followed with regard to the chairs of Anatomy, Botany, and Mineralogy, the nomination of half the Electoral Board in the case of anatomy falling to the Board of Medical Studies and in the other professorships named, to the Board of Natural Science Studies.

IN consequence of the greater importance to be given in future to the first part of the Cambridge Natural Sciences Tripos, held in June, a practical and oral examination is to be held then, two extra days being allowed for this.

THE Higher Senior Class of Mathematics in University College, London, which had been conducted by the late Prof. Clifford, has been intrusted during the summer term of the present Session to Mr. M. J. M. Hill, M.A., Fellow of the College, and fourth wrangler and bracketed equal Smith's prizeman this year at Cambridge.

DR. WITTROCK, the well-known algologist of Upsala, has been appointed lecturer on Botany, and curator of the botanical section of the museum at Stockholm.

THE commission of the Chamber of Deputies proposes to establish a compulsory system of education in France. Parents neglecting to comply with the provisions of the law are to be fined, and in certain cases to be sent to prison for a certain period. The expenses required for enlarging school accommodation and adding to the number of teachers are to be supported by the National Exchequer.

SCIENTIFIC SERIALS

American Journal of Science and Arts, March.—In the opening paper Prof. Norton contends that under varying conditions the ultimate molecules of bodies are subject to changes in the intensity of their attraction or repulsion, at a given distance of neighbouring molecules (temperature and chemical constitution remaining constant). Evidence of this is found in the phenomena of permanent distortion of materials after temporary subjection to a force of stress; in observed changes in the mechanical properties of materials, through tension, pressure, heat, &c.; change of mechanical properties of a body through presence of minute quantities of other substances; and certain facts in chemical physics (phenomena of solution, allotropy, the nascent

state, &c.). The hypothesis is advanced, that the ethereal atmosphere condensed round an atom by its attractive action consists of an atmosphere of luminiferous ether, and an envelope of electric ether immersed within this for a certain depth, an ethereo-electric atmosphere, in fact.—Some observations on flocculation of small particles (or their tendency to form, under moderate agitation, granular aggregates or compound particles of larger size), are described by Prof. Hilgard, and have important physical and technical bearings, especially on points in agriculture.—Prof. Dawson points out what he considers defects and errors in the method of investigation pursued by Prof. Möbius recently with regard to *Eozoon canadense*, leading to a decision adverse to the organic character of that object.—Mr. White offers some remarks on the Jura-trias of Western North America; Mr. Fontaine continues his notes on the mesozoic strata of Virginia, and Mr. Bannister contends for the hypothesis of the transition character of the Rocky Mountain lignite series, or Laramie group.—Some new species of anthozoa and cephalopoda added to the marine fauna of the eastern coast of North America, are described by Prof. Verrill; the cephalopoda have some specially interesting features.—Mr. Penfield gives analyses of triphylite.

Annalen der Physik und Chemie, No. 2.—In this number Herr Thoss communicates an interesting paper on artificial dichroism. He experimented (to produce it) in the three directions of making a coloured isotropous medium doubly refractive, colouring a doubly-refractive medium, and giving a colourless isotropous medium both colour and double refraction. The last series were negative in results. In the first series, plates of gutta-percha, indigo, and chrysamminate of potash gave convincing proof that there is no difference between double refraction produced mechanically and double refraction in crystals. It was found impossible to produce dichroism with pressure in coloured glass. Colouring matter in crystals is considered the real producing cause of dichroism. The subject of quickly alternating electric currents is treated by Herr Oberbeck, who notes as an important fact the diminution of the resistance of liquids by increase in the number of alternations of the transmitted current in unit time; this occurs only when the number becomes high, and the average time of passage of one constituent molecule to its neighbour in the direction of the current can no longer be regarded as infinitely small in comparison to the duration of the current. The author describes experiments on alternating currents in two induction coils, variously connected, and finds in the phenomena certain analogies to vibrations of the nature of sound and light.—Herr Lubarsch endeavours to show that the faultiness of past experiments on fluorescence has arisen only from the first of three causes assigned by Prof. Lommel, viz., absorptive action of the fluorescent liquid on the fluorescent light, in observation of the liquid mirror. He finds evidence of the generality of this law: in all fluorescent substances the more refrangible limit of the derived spectrum coincides with the place of strongest absorption in the absorption spectrum, or (where this is not distinctly perceptible) with the place of strongest fluorescence in the fluorescent spectrum. Substances with double fluorescence, as chlorophyll (the phenomena of which he describes), are not excepted from the law.—Herr Rudorff describes a simple and convenient apparatus for determining the specific gravity of powdered substances; Herr Wiedemann and Herr Schulze, an arrangement with which can be proved the dissociation of hydrate of chloral at 100°; Herr Wiedemann, experiments yielding the result that by passage of electricity a gas may become luminous far under 100°, &c.—A large part of the number is occupied with the concluding part of Kohlrausch's paper on electric conductivity, &c., already referred to.

Journal de Physique, February, 1879.—The opening paper by M. Jamin, on complements to the theory of dew is followed by one in which M. Lippmann shows that the depolarising property of a metallic solution is limited to the same metal as it contains; and that this electric reaction may be applied, in several cases, in testing for a metal, as a convenient auxiliary of chemical analysis. The electric work expended to produce polarisation is stored (he contends) not in the form of chemical energy, but in that of electrical, as in a condenser.—M. van der Mensbrugghe offers some remarks on measurement of the superficial tension of liquids, *apropos* of recent experiments by M. Terquem.—M. Gernez describes a method of observing the rotatory power of quartz at different temperatures, and which seems to meet the difficulties of the case better than that of M. Joubert and other physicists. Two quartzes of contrary rotation are fixed at the two ends of a tube, and only one is heated. A universal support or electro-diapason for inscribing and showing in projection vibratory movements is described by M. Duboscq.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 27.—"On the Organisation of the Fossil Plants of the Coal Measures. Part X." By W. C. Williamson, F.R.S., Professor of Natural History in Owens College, Manchester.

The still existing differences of opinion respecting the botanical affinities of the Sigillariæ give value to every new fact calculated to throw light upon the question. In 1865 Mr. Edward Wunsch, of Glasgow, made a discovery, which proves to have an important bearing upon it. He found, at Laggan Bay, in Arran, a series of rather thin carboniferous strata, separated by thick beds of volcanic ash, and in one of the carboniferous shales especially, he discovered the bases of the stems of numerous very large trees standing perpendicularly to the shales. These trees have been referred to by several authors as Sigillarian. In the summer of 1877 Mr. Wunsch and I employed quarrymen to make extensive excavations amongst these strata, for the purpose of adding to the extensive series of specimens which he had obtained, and the whole of which he kindly placed in my hands. The aggregate result of these explorations was to show that the conclusion previously arrived at, viz., that the stems had belonged to a grove of Sigillarian trees, was unsupported by a solitary fact. These stems were of very large size, showing that they had belonged to fully grown trees. None of them displayed any traces of leaf-scars, having outgrown the stages at which such scars would remain visible. Their outer surfaces were scored with deep irregular longitudinal fissures, resulting from internal growth and consequent expansion, and which appear to have been mistaken for the longitudinal grooves and ridges of a Sigillarian bark. Such, however, they certainly were not, since, in every instance, the surface bark had been entirely thrown off, and the fissures entered deeply into the subjacent bark layer. In most of the stems this comparatively thin bark layer was the only one that remained, the greater portion of the inner bark and the central vascular axis having disappeared, leaving a large cylindrical cavity, which was filled up with volcanic ash. These stems failed to display a single feature justifying the conclusion that they were Sigillarian.

In two of them the central cavity, instead of being filled with ash, was filled with miscellaneous heaps of vegetable matter, amongst which were large fragments of the vascular axes of various plants, such as Lepidodendra and Stigmariæ, but in one of the largest stems were five or six decorticated vascular cylinders of Diploxyloid stems, of the largest size, and which, though arranged parallel to the long axis of the cylinder which inclosed them, obviously did not belong to them, but had been floated in from without. The supposition that these had been young stems that had grown within the hollow protecting cylinders, from spores, accidentally introduced, is wholly untenable, since each one of these several vascular axes has been the centre of a stem fully as large as that within which we found them aggregated. Of course, these Diploxyloid vascular axes had the organisation which Brongniart and the younger school of French botanists which still upholds his views on this point, believe to be characteristic of true Sigillariæ—a conclusion from which I have long dissented.

The only fragments we found, that threw any light upon the character of the leaf-scars that had indented the surfaces of these fully-grown stems, was a well-defined example of the Lepidodendroid type.

We directed careful attention to the nature of the smaller fragments of branches and foliage which abounded in the volcanic ash with which the large stems were overlaid. These consisted of Lepidodendroid branches and twigs of all sizes and ages, and no doubt was left upon my mind that they were really the *disjecta membra* of the stems around which they were so profusely scattered. The only fruits that have been obtained from the same locality are Lepidostrobi, most of which contain macrospores and microspores. Unless we are prepared to believe that this Arran deposit contained, on the one hand,

numerous stems without branches, and, on the other, yet more numerous branches without stems, we must recognise in these specimens the complementary elements of a grove of Lepidodendroid trees.

One specimen found is a very important one. It has a mean diameter of six inches, and is either a small stem or a very large branch. Internally it exhibits the same structure as all the smaller Lepidodendroid branches, except so far as it is modified by size and age. But in addition to its other features, it exhibits *a very narrow* exogenous ring surrounding the ordinary Lepidodendroid one, thus giving some clue to the size attained by such branches before the internal organisation passed from the Lepidodendroid to the Sigillarian type.

The important discovery by Mr. D'Arcy Thompson, of Edinburgh, of young branches of Ulodendron with reproductive cones actually attached to the scars characteristic of the genus, finally settles the nature and functions of these scars, showing that they mark the positions from which bilaterally arranged deciduous organs of fructification have fallen.

The structure of *Calamostachys Binneyana* has had further light thrown upon it, sustaining my previously expressed convictions that it had a triquetrous axis, and that consequently its affinities were with Asterophyllites and Sphenophyllum, and not with Calamites. A specimen demonstrates that the six vascular bundles going to the six fertile sporangiophores were given off in pairs from the three truncated angles of a triangular vascular axis—an orientation absolutely indentical with that represented in similar sections of stems of Sphenophyllum, published by M. Renault. The recent discovery by Herr Stur, of Vienna, of a plant in which Sphenophylloid and Asterophyllitean leaves are found upon a common stem, establishes the correctness of my previous conclusions, as to the very close affinities of these two genera.

A large series of specimens from Oldham and Halifax has enabled me to investigate in detail the very curious objects to which Mr. Carruthers gave the name of Traquairia, and which that observer believes to be a form of Radiolarian life. Their very elaborate organisation can scarcely be made intelligible without the aid of plates. In a previous memoir (*Phil. Trans.* 1874, p. 56), I ventured to doubt the correctness of Mr. Carruthers' conclusions, and expressed my conviction that these objects resembled spores rather than protozoan skeletons. Further study of their details of structure has only strengthened this opinion which has also received the important support of Professors Hæckel and Strasburger, of Jena, both of whom have carefully studied my collection of specimens. These objects are small spheres—the sphere-wall of which is prolonged into a series of long radiating tubes not unlike the muricated species of a Cidaris. In their young state each murication gives off a delicate thread or threads, which ramified freely in an apparently mucilaginous or gelatinous, structureless, investing magma. In older specimens these threads developed into branching and radiating cylindrical tubes which, like the primary ones, had very thin walls. Within the outer sphere-wall, which consists of the coalesced bases of these branching tubes, were at least two other thin layers of membrane, and in several of the specimens the interior of the capsule is filled with cells, exactly like those seen in the corresponding cavities of Lycopodiaceous macrospores found in the Halifax deposits from which the finest Traquairiæ have been obtained. These objects differ considerably from all known reproductive structures; but I agree with Prof. Hæckel in his very decided rejection of them from the Radiolarian group of organisms, and with his conclusion that they are vegetable and not animal structures. Prof. Strasburger thinks it most probable that their affinities are with the macrospores of the Rhizocarpæ.

Myriads of the vegetable fragments both from Oldham and Halifax are drilled in all directions with rounded insect or worm borings, and further traces of these zylophagous animals are seen in innumerable clusters of small Coprolites of various sizes, the size of those composing each cluster being uniform.

Desirous of verifying Count Castracane's alleged discovery of Diatoms in coal, specimens of twenty-two examples of coal from various localities in Yorkshire, Lancashire, and Australia were reduced, after the Count's method, to a small residue of ash. This work was done for me in the chemical laboratory of Owens College through the kindness of Prof. Roscoe. Like Mr. F. Kitten, of Norwich, the Rev. E. O'Meara, of Dublin, and the Rev. G. Davidson, of Logie Coldstone, I have failed to discover the slightest trace of these organisms in coal.

The last objects described are some minute organisms from the carboniferous limestones of Rhydmwyn, in Flintshire, and which were supposed by Prof. Judd to have been siliceous Radiolarians from which the silica had disappeared and been replaced by carbonate of lime. I fail to find any confirmation of this conclusion. The objects appear to me to constitute an altogether new group of calcareous spherical organisms that may either have been allied to the Foraminifera or have had some affinities with the Rhabdoliths and Coccoliths. I have proposed for several species of the organisms the generic name of Calcisphæra. Myriads of objects of similar character, but of larger size, constitute the greater portion of a Corniferous limestone from the Devonian beds of Kelly's Island, U.S.A.

Additional light is thrown upon some Lycopodiaceous Strobili, fern-petioles, *Sporocarpous* or cryptogamic conceptacles, and other spore-like bodies, Gymnospermous seeds and stems.

Chemical Society, March 20.—Dr. Gladstone, president, in the chair.—The following papers were read:—On plumbic tetrethide, by E. Frankland and A. Lawrance. The authors prepared this compound by adding plumbic chloride to zinc-ethyl, and distilling the product in a current of steam. Ammonia, carbonic anhydride, carbonic oxide, cyanogen, nitric oxide, oxygen, and sulphuretted hydrogen, do not act on this substance at ordinary temperatures; sulphurous anhydride converts it into a white amorphous mass, consisting of diethylsulphone and plumbic ethylsulphinate.—Prof. W. Foster gave a verbal communication on the production of the higher oxides of iron, chromium, manganese, and bismuth. When the salts of the above metals are treated with an alkaline solution of sodic hypobromite, ferrates, chromates, permanganates, &c., are formed, oxygen being evolved. Copper sulphate solution, when mixed with the hypobromite solution, evolves oxygen at ordinary temperatures. —On the decomposition of water by certain metalloids, by C. F. Cross and A. Higgin. The authors conclude that pure sulphur decomposes water, uniting both with its oxygen and hydrogen; the decomposition is independent of atmospheric oxygen. Amorphous phosphorus decomposes lead acetate solution, but is without action on water at 100°. Vitreous phosphorus does not decompose water at 100° when air is excluded.—On the volumetric determination of chromium, by W. J. Sell. To the boiling solution containing chromium, acidified with sulphuric acid, permanganate is added until a pink tint remains after boiling for three minutes; the manganese is precipitated by the addition of sodium carbonate and alcohol, and filtered off; the chromic acid in the filtrate is then determined by iodine and hyposulphite. The author also gives details of a method of fusing chrome iron ore, by means of which an estimation of the chromium can be made in an hour and a quarter.

Geological Society, March 12.—Henry Clifton Sorby, F.R.S., president, in the chair.—Lazarus Fletcher, Arthur Samuel Hamand, William J. Pope, and George W. Slatter, were elected Fellows of the Society.—The following communications were read:—On perlitic and spherulitic structures in the lavas of the Glyder Fawr, North Wales, by Frank Rutley, F.G.S. He mentioned the fact that the lavas of Bala age in Wales were generally vitreous, and instanced some remarkable cases of spherulitic structure from that district. Prof. Judd stated that among the most ancient rocks of the north-west of Scotland were lavas showing spherulitic and fluidal structure. These were also common in the old red sandstone lavas. He thought that as the spherulitic, perlitic, and fluidal structures were in rocks of modern date confined to vitreous varieties, the inference was safe, when applied to ancient rocks, that they were once glass. Dr. Sheibner asked if an analysis of the rock had been made. If the rock was a true perlite, there should be about 80 per cent. of silica. If the rock was altered, one might expect a large excess of magnesia. Prof. Ramsay said that the character of these lava-flows was evident even without microscopic examination. He recapitulated the evidence which had persuaded him of this when surveying the district, and expressed doubt as to the rocks at the base of the Cambrian in North Wales being true lava-flows. Dr. Hicks said he thought there was no reason why a perlitic structure should not occur in rocks of Bala age. He thought the first spherulitic rocks recognised in this country had come from rocks of Arvonian age at St. David's. Mr. Bauerman said that modern lava-flows often cover very large areas, as in North America and India; so the mere distance of the Wrekin from Wales would be no difficulty. Mr. Rutley doubted whether spherulitic structure was

always connected with vitreous. He did not see that the presence of magnesia would prove or disprove alteration. He did not think a rock could be vitreous if solidified at a great depth, since it would hardly be able to cool with sufficient rapidity.—The gold-leads of Nova Scotia, by Henry S. Poole, F.G.S., Government Inspector of Mines. The author remarked upon the peculiarity that the gold-leads of Nova Scotia are generally conformable with the beds in which they occur, whence Dr. Sterry Hunt and others have come to the conclusion that these auriferous quartz veins are interstratified with the argillaceous rocks of the district. With this view he does not agree. He classified the leads in these groups according to their relations to the containing rocks, and detailed the results of mining-experience in the district, as showing the leads to be true veins by the following characters:—(1) Irregularity of planes of contact between slate and quartz; (2) The crushed state of the slate on some foot-walls; (3) Irregularity of mineral contents; (4) The termination of the leads; (5) The effects of contemporary dislocations; (6) The influence of strings and offshoots on the richness of leads. The author further treated of the relative age of the leads and granite, and combated the view that the granites are of metamorphic origin, which he stated to be disproved by a study of the lines of contact. He also noticed the effects of glaciation on the leads, and the occurrence of gold in carboniferous conglomerate.—On conodonts from the Chazy and Cincinnati groups of the cambro-silurian, and from the Hamilton and Genesee-shale divisions of the devonian, in Canada and the United States, by G. Jennings Hinde, F.G.S. After a sketch of the bibliography of the subject, the author described the occurrence of conodonts. In the Chazy beds they are associated with numerous *Leperditiæ*, some trilobites, and gasteropods; in the Cincinnati group with various fossils; and in the devonian strata principally with fish-remains; but there is no clue to their nature from these associated fossils. They possess the same microscopic lamellar structure as the Russian conodonts described by Pander. The various affinities exhibited by the fossil conodonts were discussed; and the author is of opinion that though they most resemble the teeth of myxinoid fishes, their true zoological relationship is very uncertain. The paper concluded with a classification of the conodonts from the above deposits.—On annelid jaws from the cambro-silurian, silurian, and devonian formations in Canada, and from the lower carboniferous in Scotland, by G. Jennings Hinde, F.G.S. After referring to the very few recorded instances of the discovery of any portions of the organisms of errant annelids as distinct from their trails and impressions in the rocks, the author noticed the characters of the strata, principally shallow-water deposits, in which the annelid jaws described by him are imbedded. A description was given of the principal varieties of form and of the structure of the jaws. They were classified from their resemblance to existing forms under seven genera, five of which are included in the family Eunicea, one in the family Lycoridea, and one among the Glycerea. The author enumerated fifty-five different forms, the greater proportion of which are from the Cincinnati group.

Meteorological Society, March 19.—Mr. C. Greaves, F.G.S., president, in the chair.—The following were elected Fellows of the Society:—R. Burniston, W. H. Crawford, J. Davies, The Earl of Derby, H. Downs, S. Egar, J. S. Hodgson, S. Hollins, T. M. Hopkins, H. Horncastle, C. W. Johnson, E. M. Nelson, and F. Wilkin.—The papers read were:—Dew, mist, and fog, by George Dines, F.M.S. The author has during the last two years made a number of experiments to determine the amount of dew that is deposited on the surface of the earth. The plan adopted was as follows:—Glasses similar to ordinary watch-glasses were procured; the surface area and the weight of each was ascertained. These glasses were exposed to the open air in the evening, being placed on different substances, viz., on grass, on slate, and on a deal board, the two latter being raised a few inches above the grass. A minimum thermometer was generally placed by the side of each glass. It is only on rare occasions that an amount of dew exceeding the 0·010 inch in depth has been deposited upon the measuring glasses, and out of 198 observations, in only 3 has that amount been exceeded. Fifty-eight observations give the amount from 0·010 to 0·005 inch: 107 from 0·005 to 0·001 inch; 22 less than 0·001 inch; and 8 observations no dew at all. The author thinks it may be fairly assumed that the average annual deposit of dew upon the surface of the earth falls short of 1·5 inch. There are two kinds of mist, the morning and evening; the morning mist is caused by the evaporation from the water and the moist ground taking place faster than the vapour is taken away; the air becomes saturated, but this does not stop the evaporation; the vapour continues to rise into the air, is there condensed, and forms mist, which gradually spreads over a wider surface. The evening mist is produced as follows:—The cold on the grass caused by radiation lowers the temperature of the air above it; the invisible vapour of water previously existing in the air is in excess of that which the air can retain when the temperature is lowered; the surplus is condensed, becomes a mist-cloud, and floats in the air just above the surface of the grass. Taken either separately or combined, the mists appear to the author totally and altogether inadequate to account for those dense fogs which at times overspread large tracts of country. Dense fogs near the earth are often accompanied by a clear sky above, when the sun may be seen reflected from the gilded vanes of our public buildings. After long consideration the author is inclined to attribute these fogs to some cause at present unknown to us, by which the whole body of the air to some distance above the surface of the earth is cooled down, and, as a consequence, part of the vapour in that air is condensed and forms what has been called an "earth-cloud."—On the inclination of the axes of cyclones, by the Rev. W. Clement Ley, M.A., F.M.S. The object of this paper is to call attention to the evidences recently afforded by the results of mountain observations to the theory that "the axis of a cyclone inclines backwards." The author first reviews the state of the question up to the present time, and details his own investigations, chiefly founded upon the movement of cirrus clouds; he then refers to Prof. Loomis's recent "Contributions to Meteorology," in which is discussed the observations at the summits and bases of several high mountains, the results of which fully confirm the theory that the axis of a cyclone inclines backwards. The discussion on this paper was adjourned till the next meeting.—Contributions to the meteorology of the Pacific. No. III. Samoan or Navigator Islands, by Robert H. Scott, F.R.S.

Physical Society, March 22.—Prof. W. G. Adams, president, in the chair.—New Member, Capt. Hastings R. Lees, R.N.—Capt. Abney, R.E., F.R.S., read a paper on obtaining photographic records of absorption spectra. Absorption spectra have hitherto been recorded by the difficult method of hand-copying; but the discovery by Capt Abney of a silver salt sensitive to all rays in different degrees renders the photographic method available. The records thus obtained are photographs of the spectrum of the naked light of the source and of that of the same light reduced by insertion of the absorbing material in its track, and these are taken parallel, so that the dark absorption lines can be readily compared. Examples of these were thrown by him on the screen. This method can be used as a new weapon in attacking solar physics and determining whether or not compound bodies exist in the sun. Absorption spectra to compare with the sun can be got for compound bodies by burning the matter in question in a flame in front of the slit and passing a bright light through the flame.—Prof. Guthrie, F.R.S., then read a paper on the fracture of colloids, as illustrated by experiments on the breakage of glass plates either by pressure or heating at the centre or round the circumference. Circular plates of glass, pressed at centre or circumference, break in radial lines. However supported, a plate breaks in the same fashion if heated in the same way. If heated in the middle the crack is peak-shaped, like an obelisk on a double pedestal, two cracks forming the outline, with sometimes a third down the middle. The two cracks unite before they reach the edge on one side, and (as afterwards pointed out by Prof. W. G. Adams) the three extremities of the two cracks all meet at right angles to the edge. The crackage varies with the size and shape of the plates, the flame, and kind of glass; but the type is the same for all. Cracks cross each other. Prof. Guthrie defined a crack as the line where the ratio of cohesion to strain is least, and likened it to the lightning flash. Mr. W. Chandler Roberts, F.R.S., said that he had observed once a volute spiral crack in dried hydrated silicic acid, and recommended Prof. Guthrie to study cracks in agate, which is the most perfect colloid known.

GENEVA

Society of Physics and Natural History, November 6, 1878.—M. Raoul Pictet read a paper on temperature and on the general synthesis of all calorific phenomena. The purpose of this research is to prove the absence of rigorous definition of the word "temperature," the *petitio principii* on which the construc-

tion of all thermometers rests, and the confusion which exists in most of the treatises on physics between the terms: heat, sensible heat, latent heat, and temperature.—M. Arthur Achard described certain considerations relative to the useful effect of magneto-electric machines, and spoke especially on some experiments made by Prof. Hagenbach of Bâle with a Gramme machine (see *Archiv des Sc. Phys. et Nat.*, vol. lxiv. p. 332).—Prof. Schiff spoke of the electric currents observed in animals. Most of them proceed from the glands of the skin, which are veritable electrical apparatus. If we destroy the skin or cauterise it, currents are produced which are attributed to the muscles, but which proceed from the movements of the animal. The observations were made on the protics.

November 21, 1878.—Prof. Soret communicated the results of his researches on absorption spectra by means of the eye, especially with respect to ultra-violet radiations. He operated on the eyes of oxen and calves, and he found that the ultra-violet radiations were transmitted as far as the S line. The aqueous humour allows them to pass as far as V. The vitreous substance has a transparency much greater than the aqueous humour.—M. Raoul Pictet presented several considerations on the passage to a liquid state of compressed gases, and in that state the limit which is produced for each gas at a certain pressure and a certain temperature.

December 5, 1878.—M. J. M. Crafts showed a new thermoscope, a description of which he recently published, and the air-reservoir of which is only $\frac{1}{10}$th of a cubic centimetre. From experiments made with this instrument he concludes that the physical characteristics of different bodies are much less dissimilar at high than at low temperatures.—Prof. Schiff experimented before the Society on a seismograph of M. Ziegler, consisting of a tube of gold-beater's skin, with which he envelopes the member whose variation of volume he wishes to measure, corresponding to the beatings of the pulse. This large tube communicates its impressions to a registering apparatus by means of a very narrow tube.—Prof. Joh. Müller gave an account of very delicate microscopic observations made by him and M. Minks on lichens, and overthrowing definitely the theory of Schwendler (See *Arch. des Sc.* Jan. 1879, p. 49).

PARIS

Academy of Sciences, March 24.—M. Daubrée in the chair.—The following papers were read:—On the slow changes undergone by wine during its conservation, by M. Berthelot. These observations relate to bottles of port 100 and 45 years old respectively, which the author analysed. *Inter alia*, the cane-sugar in the older wine had disappeared almost completely; and there was very little in the other. The wines must have lost more than a fourth of their acidity through etherification. The amount of cream of tartar was much under the normal solubility. The alcohol was in like proportion to that of recent port, there had been little change in it, therefore, probably. As to gases, one litre of the wine contained 12·4 cc. oxygen, and 32·3 cc. nitrogen, without carbonic acid; corresponding to normal saturation of the wine by the gases of air. In saturation with oxygen this old wine contrasts with recent Burgundy wines, which have no trace of it in solution, but which contain CO_2, while the old ports have parted with this through diffusion.—Remarks on some points of crystallogy, by M. Lecoq De Boisbaudran. He makes inferences from the unequal resistances of different faces of a crystal to change of state. The solubility of the crystal must vary with its exterior form. The peculiar mode of regeneration of mutilated crystals is easily explained; also the influence of rapidity of growth on relative development of the different parts of a crystal, &c.—Communications on several geographical questions, by M. de Lesseps. These relate to inter-oceanic canals and a conference on the subject, to be held in Paris on May 15; news from M. Soleillet on the banks of the Niger, and from Serpa Pinto, announcing important discoveries on the course of the Zambesi; news also from M. Roudaire at Gabes.—Addition to a previous note on damming the Tiber at Rome, by M. Dausse.—Observations of Brorsen's periodic comet, by M. Tempel.—Formulæ relating to perturbations of planets, by M. de Gasparis.—On resolving equations, by M. Pellet.—On the solution in whole numbers of the equation (1) $aX^4 + bY^4 + dX^2Y^2 + fX^3Y + gXY^3 = cZ^2$, by M. Desboves.—Molecular vibrations in magnetic metals during passage of undulatory currents in these metals, by M. Ader. Such vibrations are thus had in all the magnetic metals, and give articulate sounds. To have them in all their intensity, a mechanical action must be opposed to the wires or bars, especially the inertia of two heavy masses at their extremities. The effects of these electrodynamic vibrations, and the conditions of mechanical actions to be opposed to the bars are quite the same as those the author has indicated for electro-magnetic molecular vibrations.—On ytterbine, the new earth of M. Marignac, by M. Nilson.—On *scandium*, a new element, by M. Nilson. The preparation of ytterbine (which he describes) furnished a substance with molecular weight 127·6 instead of 131, indicated by M. Marignac; and M. Nilson was led to suspect the presence of another earth, of lower molecular weight, mixed with the product examined. The spectroscope favoured this idea, and M. Thalen indicates the lines proper to the spectrum of the new earth. The name given to the new element is meant to recall its presence in gadolinite or euxenite minerals, found only in the Scandinavian peninsula hitherto. The atomic weight is under 90. M. Nilson remarks on some of its chemical properties.—On the cyanosulphite of potassium, by M. Etard.—Thermochemical study of alkalino-earthy sulphides, by M. Sabatier.—On various alcoholic iodides and bromides, by MM. De Montgolfier and Giraud.—On the formation of aurine, by MM. De Clermont and Frommel.—On the presence of lithine in rocks and in the waters of seas; consequences relative to saliferous strata and to certain classes of mineral waters, by M. Dieulafait. Lithine is as widely distributed as soda and potash, and accompanies these two bases in all rocks of primordial formation. It exists in the Mediterranean and other seas in such quantity that it can be recognised in the residue of evaporation of even one cubic centimetre. It concentrates notably in the sediments of salt marshes. Marls in small quantity give an intense spectrum of lithine. All waters mineralised in the primordial formation contain lithine, and all waters distinctly saline contain it in exceptional proportion.—Resistance of germs of certain organisms to the temperature of 100°; conditions of their development, by M. Chamberlaud. He describes two forms of *Bacillus*, whose germs have this resistance; boiling water several minutes or even an hour will not kill them.—On the presence in the blood and tissues, under spheroidal form, of certain liquids not miscible in water and which have penetrated through the lungs, by M. Poincaré. Spirit of turpentine and nitrobenzine are among the substances observed to have this effect. The fact bears on respiration of noxious vapours by workmen.—Anatomical and physiological study of nectaries, by M. Bonnier. He rejects Darwin's theory of the *rôle* of nectaries. Nectariferous tissues, floral or extra floral, emitting a liquid or not, form special nutritive reserves in direct relation with the life of the plant.—Experimental researches on the conditions of growth of root hairs, by M. Mer.—On a new disease of the Rubiaceæ of hothouses, by M. Cornu.—On halos and parhelias seen in the park of Saint Maur, by M. Renou.—On the unity of forces in geology, by M. Hermite.

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