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NATURAL SELECTION AND ALTERNATIVE HYPOTHESES.

Animal Coloration: an Account of the Principal Facts and Theories relating to the Colours and Markings of Animals. By F. E. Beddard, M.A., F.R.S. (Swan Sonnenschein & Co.)

THE theory of natural selection has been pre-eminent for over thirty years as the most generally accepted explanation of organic evolution. It has, and has had throughout, many critics; but its position is strengthened by the fact that these critics invariably accept the principle as accounting for something, while most of them make it clear that they reject all other proposed substitutes, except those for which they are individually responsible. Sometimes the attempt to formulate an alternative hypothesis, or to apply it to the facts of nature, breaks down as soon as it is undertaken. A curious instance of this is to be found in Semper's "Animal Life," which begins with very large anticipations:—all the "popular cant" of the Darwinian is to be "put out of court as useless"; a selective explanation can never be a real one, but for the latter we are to consult the subsequent pages. But as case after case is examined, the author is constrained to admit that his real explanation is not forthcoming, and that, although he never will think much of selection, it is the only cause he has to offer. Semper would appear to have written his preface before he considered the materials from which he proposed to write his book.

Mr. Beddard's work does not open in this ambitious manner, but he is far bolder in offering alternatives to natural selection, and in applying them. Further consideration would probably have brought him to Semper's admission, at least as regards many of his suggestions. Indeed, the number of these suggestions, and the confidence with which they are brought forward, are clearly due to haste and want of sufficient reflection, which also leave their mark upon the scheme of the volume and the number of contradictory statements to be found in it. Nor is this to be wondered at when the amount and variety of work which the author accomplishes is borne in mind. But the result will be to confuse the beginner and the untrained student. Principles which are supposed to be refuted in one part, are subsequently introduced with considerable enthusiasm as the heads of the main sections of the work, and are later on again treated with scant courtesy. In fact some readers will rightly infer that the author is a profound sceptic as to the value of the scheme he nevertheless adopts. Others may perhaps be led to suppose, by the arrangement of the book, that the author is sceptical of his own scepticism. Even the very fairness of the author in giving the arguments in favour of views he rejects, will be, such is the system pursued, a cause of confusion to a reader. These sources of difficulty are not only apparent in the general scheme; particular explanations are disputed in one part, and adopted a little further on without a word of explanation.

The chief value of the book lies in the fact that it is straightforward, and speaks out on points of great difficulty and dispute. Arguments of which echoes have been already heard, perhaps, in the report of some conversation which is supposed to have taken place, or which have been crudely stated in the publications of unknown writers, are here met with in a form in which they can be dealt with. For thus stating the opinions which are vaguely supposed to be held, perhaps vaguely held, by others, every Darwinian owes a debt of gratitude to the author.

The main aim and purpose of the book would appear to be a criticism of natural selection as applied to the explanation of the colours of animals, and the proposal of alternative explanations.

Some of the difficulties which the author finds in the theory of natural selection appear to follow from his conception of the process itself. Thus, on p. 12, he speaks of polymorphic species appearing in two or more well-marked forms, and of those extreme cases of variation known to entomologists as "varieties," and concludes, "In fact, if colouring were really constant for a given species, there would be no chance for natural selection"; thus implying that natural selection depends upon such pronounced divergences, instead of upon those minute differences which distinguish the individuals of every species. He then continues, "Supposing that a marked variety occurs in a wild species, there is, first of all, a considerable chance against its reaching maturity; secondly, there is a considerable chance against its finding a mate; thirdly, the hereditary influences on both sides are against the perpetuation of the variety. These appear to be more potent causes of the comparative fixity of colours in wild animals than the unfitness of the varieties to live." It has already been pointed out that the "marked variety" is of little importance for natural selection as compared with the individual difference. But if the objections urged were valid there would appear to be little chance of a "marked variety" existing in any numbers and persisting from generation to generation, side by side with the normal form: and yet numbers do persist. As to the first of the alleged objections, the chances are against *every* individual, but not equally so, if there be anything in natural selection. So far from this objection being valid, it is but the expression of a fact upon which natural selection rests, the fact that many more individuals of every species are born into the world than can by any possibility survive. Were this not so all selection would cease. The second difficulty certainly does not apply to minute individual differences which occur in vast numbers. To take the simplest case, let us suppose that the individuals of a species are divided, as regards any character, into two equal groups—the one above, the other below the mean. It is clear that each individual would stand as good a chance of mating within the limits of its own group as within those of the other. The third objection does not appear to me to hold in the case of "marked varieties" any more than with individual differences. The total hereditary influence of the varying side, allowing even considerable force for atavism, is certainly in favour of the variation. Furthermore, experience shows us that among the offspring will be some that vary even further than their parent. Those who accept the Darwinian principle do not expect heredity to achieve more than this—to offer the materials which can be accumulated by natural selection.

Interesting as is the study of such "marked variations" and the statistics of their occurrence in nature, the great principle of natural selection, whether applied to the evolution of animal colouring or to any other character, is not greatly affected thereby, but rather demands such exact numerical investigations as those published by Galton upon man, by Wallace upon various animals, by Weldon upon *Crangon*, and by Lloyd Morgan upon bats.

Another objection to the natural selection argument is given on p. 25, and it too turns on the author's conception of the mode in which this principle operates. Recapitulating Weismann's argument that longitudinal stripes have been replaced by oblique ones in certain larvæ, on account of the more perfect concealment afforded by the latter, he points out that some species "have, on the contrary, remained at a stage of coloration which is, *ex hypothesi*, disadvantageous." The longitudinal striping was never disadvantageous, but only relatively less advantageous, in certain species, and under certain conditions. The failure of a species to take this line of evolution may have been due to many causes, the development of other modes of defence, the nature of its peculiar environment, or may be solely due to the kind of selection exercised by its foes.

The author sees far-reaching conclusions against the principle of natural selection in the admission that pigment as a cause of colour was originally non-significant, and is so still in many cases (colours of certain lower forms, colours of blood, fat, &c.). He argues (pp. 68-70) that as colour did not arise by natural selection, it must be a normal product of the organization, and its disappearance in cave-dwelling forms cannot be due to the cessation of selection, but must follow as the direct effect of surroundings, although he does not even hint at the mode in which such effects are supposed to be wrought. But these conclusions are by no means warranted by the original admission. The first appearance of pigment in the skin of the ancestor of a group of species which are now coloured was certainly a normal product of the organization; but the fact that this variation subsequently spread over all the individuals of the ancestral species, and of those to which it gave rise, will be claimed by Darwinians as the result of selection. And so strong are the tendencies of variation in other directions that partially or completely albino races can be produced by man in a relatively short period of time, while such individuals are far from uncommon in nature in spite of selection. The facts support the opposite conclusion that the absence of colour from the skin would be the normal result of organization for the average individual, were it not for the strong and continuous action of selection. There are other instances of the disappearance of colour in addition to that which has occurred in caves, and in some of these the conclusion appears inevitable. The whiteness of birds' eggs laid in dark holes certainly cannot be traced to the direct action of surroundings, any more than the colour of eggs laid in open nests; and natural selection being prevented by man, the colour is disappearing from the eggs of the domestic fowl, just as it is lost in other species when prevented by darkness.

It is certainly true that colour "must be there before it can be acted upon, and modified in this or that direction according to the needs of the animal." But this objection, which has been familiar since the earliest days of natural selection, is less formidable than it appears to be. Colour must have been present in the skin of some individual ancestor certainly, but its *existence*, as well as its modification, in the normal individual of the species is to be explained by selection.

It is hardly necessary to point out that this argument does not apply to colours which still remain non-significant and are excluded from selection; but these are precisely the colours which are unaffected by the changes of environment alluded to above; the blood of cave-dwelling vertebrates remains red like that of others; the yolk of eggs laid in holes does not differ in appearance from that of those laid in open nests.

A similar argument as to seasonal change of colour in arctic animals may be answered in the same manner.

The author's difficulties appear to arise in part from his inadequate conceptions of the struggle for existence. Speaking of certain night-feeding caterpillars, he says (p 102): "It may be suggested that they prefer to feed early in the evening, when their colours, if conspicuous, would be readily seen. If this is so, it does not much matter, for the birds would—the bulk of them at any rate —have gone to roost." Or speaking of *Mimnonectes*, an Amphipod crustacean which bears a remarkable likeness to a *Medusa* well defended by stings, he objects to attribute any significance to so wonderful and detailed a superficial resemblance, because "a school of whales or a shoal of pelagic fish, rushing through the water and devouring all before them, could hardly be supposed to stop and analyze carefully the advantages or disadvantages of selecting or rejecting a given animal as food." On p. 115 he remarks: "If Mr. Poulton is right in assigning a protective value to the bright-coloured wings of butterflies, 'as a conspicuous mark easily seized by an enemy, and yet readily tearing without much injury to the insect,' it seems unnecessary to pay much attention to the supposed utility of protective colours, such as are shown by the *Kallima* or the Green Hairstreak."

The author scoffs at natural selection as an "easy" road to an explanation, as "the very simple hypothesis of a need for resemblance to the environment": it may at any rate be maintained that this method of meeting it is very far from profound.

It is only possible to give a very brief account of the causes which the author would propose to substitute for natural selection. The merits of each proposal lie in its application, and the consideration of this means a discussion of each particular case.

In support of the "effects of food upon colour," a number of examples are quoted, many of which are so inherently improbable and so imperfectly supported by details, that it is impossible to accept them as evidence. I am very far from disputing that changes of colour may be directly produced by certain foods, although the significance of such changes in the evolution of animal colouring is a very different matter. When the author proceeds to apply this principle he falls into errors which a little consideration would have avoided. Thus, on p. 21, the following sentence occurs:—"Seeing that pigment has been proved in so many cases to be alterable by changes in the food, it is not surprising to find that as a rule the colours of larvæ are totally different from those of the adult form;" implying that the difference of diet accounts for the difference of colour,—a conviction stated even more strongly on the next page. It is quite sufficient answer to this hasty conclusion to point out that the colours of the imago are just as dependent on the larval food as the larval colours themselves, and that they have made their appearance long before the imago has had the opportunity of feeding. Again, in speaking of the "strong superficial likeness" of the Drone-fly (*Eristalis tenax*) to a bee, the author hints at likeness of food as a possible explanation (p. 232). "It is an interesting fact, in connection with the resemblance between this fly and a hive bee, that it feeds upon pollen and honey. This fact *may* have some significance in relation to the effects of food upon form and coloration." But the form and coloration of *Eristalis* depend upon the food absorbed by its "rat-tailed" larva, living in putrid mud, under conditions utterly unlike those of the larval bee.

Under the consideration of light as a cause of colour an extremely bad piece of reasoning is adopted from Werneburg (p. 62), who argues that light has an important influence on the formation of pigment during the pupal period. By selecting favourable instances and describing them with an enthusiasm which borders on inaccuracy (*e.g.*, speaking of *U. sambucaria* as "bright yellow") and by neglecting all others, he makes it appear that there is something to be said for this view.

In the section on "Variable Protective Resemblance in Chrysalids," the results of recent work are given very inaccurately; the golden colour of pupæ is explained as due to "thin films of air or some gas," and it is even suggested that "intense light may cause some gas to be given off in greater abundance." But it was shown years ago that the appearance is due to some lowly refractile liquid, and, in fact, alcohol answers the purpose very well indeed. Gases do not appear to have the power of entering the intervals between the cuticular lamellæ, perhaps because the latter come together and obliterate the chinks on the evaporation of the fluid. Again, it is stated that "the pupa was also made to assume a light colour upon one half and a dark colour upon the other." As a matter of fact the invariable failure of the pupa to do this formed the basis of some of the principal conclusions reached. It was also surely unnecessary to quote an ignorant assumption of Eimer's on the subject—an assumption which was not even original, and has been disposed of long ago.

In favour of the effects of climate reliance is placed on Scudder's conclusion that melanism is only found in the butterflies south of New York, albinism only to the north (p. 55). And yet in Europe melanism is especially prevalent among the northern moths, from which we may infer that the American observations, however they are to be explained, are not direct effects of climate.

He suggests that the blackness of a lizard on one of the Canaries may be due to moisture; but these islands are about as dry as small oceanic islands can be. All the lizards seen by the present writer in Teneriffe and Grand Canary, some three or four species, were dark in colour and harmonized with the tint of the dark dry volcanic rocks on which they were seen, and among which they almost invariably escaped when pursued.

One suggestion is very remarkable. After giving reasons why he does not consider that the resemblance of *Volucella* to humble-bees, &c., is to be explained as a case of aggressive mimicry, the author suggests (p. 228), "If wasps and bees have the same unintelligible liking for keeping pets that another group of Hymenoptera—the ants—have, the whole series of facts may prove to have a very different meaning, but one which is not quite in accord with the theory of mimicry on the part of the *Volucella*." The keeping of pets by ants is so very far from being unintelligible in some of the most important cases (*Aphides*, Lycænid larvæ, &c.) that we may fairly expect an explanation in other instances. But even if the author's suggestion were valid it would still fail to account for the very point at issue—the great superficial resemblance of *Volucella* to Hymenoptera.

On p. 92 he is quite prepared entirely to dispose of all advantages in the struggle for existence in favour of fertility; this alone is enough to prevent extermination. Speaking of the wonderful disguise of Geometer larvæ (and if this be not the result of selection it must be admitted that the principle fails indeed) he says, "In the meantime the excessive fertility of the parent moths appears to be a sufficient guarantee against extinction, apart from any subsidiary advantage to be gained by colour protection." It is sufficient reply to this statement to point out that the fertility of these small-bodied moths is very far from excessive when judged from an insect standard; that if the larvæ are offered to any insect-eating animals they are when detected, devoured with the greatest avidity, but that if offered motionless on their natural food-plant they are often passed over; that insect-eating animals, especially when rearing their young, are by no means fed to repletion, so as deliberately to refuse the food they evidently relish.

It is very confusing after this candid avowal to read a few pages further on (p. 97), "On the whole, it seems more profitable to a caterpillar to adopt protective resemblance to its surroundings as a means of escaping its foes; at any rate, this is what actually occurs. 'The main purpose in life of a caterpillar,' says Mr. Scudder, 'next to feeding, is *not to be seen*.'"

Many quite irresponsible suggestions, which it would have been wiser to have withheld unless accompanied by at least some evidence, are made or adopted from other writers. Of this nature are the remarks of Leydig on the colours of *Helix nemoralis*, and the author's suggestion that the dark variety of the female Silver-washed Fritillary may be due to the moisture of wooded districts.

Of some of the author's suggestions we may use his own words, and say, "This explanation has an air of reasonableness, which might lead to the inference that it had been amply tested by actual experiment" (p. 64). Others however, including some which have been quoted here, certainly appear to lack this "air of reasonableness."

The author is especially candid and straightforward in bringing forward the evidence in favour of an explanation he is about to attack. After thus fairly showing the strength of the opposed position, he proceeds to reject it for reasons which will strike the instructed and uninstructed reader alike as singularly inadequate. Examples of this method occur continually throughout the volume. As an example may be selected his treatment of the opinion that the light of phosphorescent organs enables certain deep-sea animals to see. He admits the existence of eyes, the prevalence of phosphorescence, the intensity of the light emitted, the existence of "lens-like transparent bodies serving to concentrate the rays of light," the fitness of the light to illuminate the prevalent colours. In spite of all these facts the author believes that all deep-sea colours are unseen and meaningless for the following remarkable reason :—"The presence of well-developed eyes, or the total absence of these structures, are, as has been explained, intelligible on the theory of abyssal light ; not so the existence of eyes in an intermediate condition. The inevitable conclusion, therefore, from these facts appears to be that the brilliant and varied coloration of deep sea animals is totally devoid of meaning ; they cannot be of advantage for protective purposes, or as warning colours, for the simple and sufficient reason that they are not seen" (p. 37). The author carries this conclusion to its logical end, and, pointing to the resemblance of deep-sea forms to their shallow-water allies, and the existence of protective resemblances in both, he maintains that "if natural selection has been the cause in the one case, it ought to be in the other. . . . . The question therefore is pressing : need natural selection be responsible for the coloration of the shallow-water forms?" (p. 38). A somewhat large conclusion to base on the fact that the eyes of certain deep-sea animals are in process of degeneration ! The author admits that the *absence* of eyes is no argument for his views ; and yet, in every such instance, a gradual process of degeneration has been passed through. He gives us no reasons for rejecting the opinion that the cases upon which he bases such startling conclusions are merely tending in the same direction ; indeed, elsewhere (p. 11) he insists on the probability that such biological changes are still progressing. It is indeed most probable that light is far from widespread or intense on the floor of the ocean, and that, therefore, eyes to be of use must be unusually efficient, while, unless absolutely necessary, they are likely to disappear. We meet, in fact, with a case somewhat parallel to that of beetles on oceanic islands in tempestuous zones, where selection operates in opposite directions—towards unusual powers of flight, when flight is a necessity, and towards the total loss of any such capacity when it is unnecessary. Thus, among deep-sea fish we find eyes of immense relative size, as well as those which are degenerate. And the phosphorescent organs of certain fish (*Ceratias*) appear to emit a light which is invisible to the degenerate eyes of the possessor, but serves to attract other and better endowed fish upon which the *Ceratias* feeds. The frequency of this degeneration among the deep-sea Crustacea, which impressed the writer so profoundly, may very probably be due to conditions of life which render vision less necessary for them than for many other groups, and this is especially probable since many shallow-water genera are sightless, as is abundantly shown in the book itself (p. 36).

On pages 115, 116, the author adopts Prof. Weldon's objection to the usually received interpretation of the whiteness of certain eggs, and the under-sides of fish, porpoises, &c., which are seen from below, on the ground that snow-flakes appear almost black when seen from beneath against the bright sky. The original suggestion is due to neither Mr. Wallace nor to the present writer, but to Erasmus Darwin, writing very nearly one hundred years ago. The objection entirely misunderstands the hypothesis, at any rate so far as the eggs are concerned. If an egg, lay exactly over one of the interstices in the nest, it would, of course, shut out the sky altogether, and when viewed from some distance through the opening would appear dark like the nest itself. There would be no question of its appearing against a back-ground of sky. As a matter of fact, no such continuous back-ground can be seen through the nest at all. Minute bright points are seen through the interstices of the nest, and those of the leaves and branches above and below it. The hypothesis in question suggests that part of the bright white side of an egg, viewed obliquely from below through an interstice, may be mistaken for one of these bright points. The hypothesis may be erroneous, but it is not to be set on one side by a criticism which fails to understand it. In the case of the fish, the question is complicated by the absorption of light by the layer of water.

The reader who finds that the above-quoted criticism is held to be destructive by the author, may be excused strong language when he meets with the following sentence only seven pages further on :—"Among pelagic fish it is common to find the upper surface dark-coloured and the lower surface white, so that the animal is inconspicuous when seen either from above or below."

The chapter on Warning Coloration is one of the most valuable parts of the book, for in it we meet with a solid contribution to the subject in the form of some interesting experiments conducted by the author upon the animals in the Zoological Gardens. Many of the results are of extreme interest, and are a further proof of the difficulty of the investigation, and the great care with which it must be conducted if the conclusions are to be depended upon. It has been already suggested that some of the results may be perhaps explained by the fact that the insect-eating animals chosen for experiment are restricted to a very monotonous or very scarce insect diet. In some rather extensive experiments made by the present writer upon a marmoset, it appeared that the animal possesses a most keen appreciation of the meaning of warning characters, but the individual in question was accustomed to be fed on a very varied diet. The discussion of the details given in this chapter cannot now be attempted, but it may be safely affirmed that there is nothing which is fatal to the theory of warning colours, when we admit, as we are of course bound to do, that even unpalatable animals have their special enemies, and that the enemies of palatable animals are not indefinitely numerous.

Further criticism of the arguments is rendered impossible on the present occasion by the exigencies of space. Certain obvious misstatements call for correction, such as the description of the jet black larva of the Peacock Butterfly as "dusky greenish" (p. 21), the assertion that the present writer discovered uric acid in the excreta of Vanessid imagos (p. 41), the implication that leaf-mining larvæ eat only the deeper tissues of the leaf instead of everything between the upper and lower cuticle (p. 63), the description of "red eye-like markings upon the blue underwings" of the Eyed Hawk Moth (p. 134), in which red and blue should of course be transposed.

The book is well printed, misprints such as "Tortorix" for "Tortrix" (83), "freshly-moulded" for "freshly-moulted" (67), "distinction" for "distinctive" (185) being fortunately uncommon.

The coloured plates are good, although it would have been a pleasure to see the wings of one of the resting *Volucellæ* in Plate IV. folded one over the other in a very characteristic attitude. The antennæ of the *Kallima* shown at rest in Plate II. would have been concealed, and the same applies to the figures of the Buff-tip and Lappet Moths. The worst figure is that of the Bee Hawk Moth on p. 245, in which an entirely wrong notion of the opaque border to the wings is conveyed. The source of the figures is not mentioned.

EDWARD B. POULTON.

SUNSHINE.

Sunshine. By Amy Johnson, L.L.A. (London Macmillan and Co., and New York, 1892.)

THIS book is likely to puzzle any one who may by chance pick it up and glance casually over the pages, more especially if he should happen to first open it towards the end and find two chapters headed "Tommy's Dream," concluding with a conversational account of how "the nurse puts baby into a bath, generally too hot or too cold, and scrubs away as if he were a wooden doll. · Poor baby's skin is red all over, and he screams with pain," &c. On the other hand, in the early part of the book, several familiar figures, such as pictures of ice flowers, or diagrams of the action of simple lenses, of total reflection, of the rainbow, &c., show that "Sunshine" is, in spite of the nursery episode, in reality connected with physical science. As a matter of fact the authoress has taken a number of easy experiments and every-day observations, and has amplified and explained them in a simple and often very charming manner, adopting for the purpose the conversational form as between herself, called teacher, and, judging by the number of Christian names of the children addressed, a host of youngsters.

The conversational style is out of fashion just now, but no objection can be taken on that account. What is of far more importance is the general effect produced upon the mind of the child. The writer of this notice well remembers how the attempt was made to beguile him into being interested in conversations between a horridly precocious child Willie and his papa. Willie always said the right thing, and always made the right mistakes, so that much instruction was to be gathered from the answers and corrections of his papa. The writer, no doubt, did acquire some general information; perhaps he did not resent the attempted deception, but he is sure that he would like to have punched Willie's head, or to have made him suffer in some way that is pleasing to the boyish imagination. In the present instance the risk of arousing open hostility on the part of children who may receive instruction from the pages of "Sunshine" is largely reduced by the fact that the conversation is very one-sided; the children are made to say very little in these talks—they are not quite lectures, but more lectures than conversations. Whether "teacher" says too much, or in the attempt to appeal to the imagination rather than the reasoning faculties of her audience rambles too far afield, is a question of taste. Many parts of the book demand the highest praise, though in some the authoress seems to have gone beyond reasonable bounds. For instance, after a most clear and excellent illustration of the method by which the distance of the moon from the earth is determined, in which the children are made to find by folding paper how far it is from the table to a ball hanging up in the room, the imagination of the reader is stimulated as follows:—

"At the beginning of our 'talk' about the moon, I tried to impress upon you what old travellers you were. Do you remember how far you have been each year? (585,000,000 miles.) And you, Tom, are——?" "Seven." "What age are you, Percy?" "Eight." "And you, Minnie?" "Nearly eight." "You shall work that sum out for me on your slates. We will neglect the travelling since last birthday. Multiply 585,000,000 by 8, Percy. Four thousand six hundred and eighty millions of miles, you say. Have you felt any pain or sickness? Are you willing then to accompany me for a little 'out' to call on our next neighbour, the moon? It is only 240,000 miles, and would take us a little over three hours and a half at earth's usual rate of travelling. Do you think your mothers would trust you with me if I guaranteed to bring you safely back again? Most of you say 'Yes.' What is it that Ethel is saying to you, Lucy?" "She wants to know if we are really going, or if it's 'only pretending.'" "That is a question which Ethel must decide for herself. Those who are going with us must be ready in time, or they will be left behind. Before we make a journey it is usual to consider, not merely the distance, but a few other matters also, such as—'What to take with us,' 'How long we shall be away,' 'Where we can get lodgings,' 'Whether we should take shawls, umbrellas, &c.,' and so many other considerations, that I am afraid we can't go to-day. Make all inquiries at home, and let me know how many of you are prepared to go."

As has been stated, the imagination rather than the reason is being constantly appealed to, and for the purpose the most picturesque language is employed. Perhaps the most striking example is to be found in a chapter headed, "The Mill with Stained Glass Windows." A beam of sunlight is made to pass through a condenser and into a slit. Then slips of coloured glass, red, green, and violet, are placed edge to edge over the slit, and the red-green-violet line of light is looked at through a scratch in a piece of smoked glass. The resulting diffraction phenomenon is the mill with stained glass windows. The upper story with violet windows has a greater number closer together than the second story with the green windows, and there is the same difference between this and lower story with the red windows. From this result by a simple step the coloured bands seen when white light is employed are readily explained. Of course, and wisely so, no attempt is made to explain why with monochromatic light the windows are seen at all. In the same manner most of the phenomena described or which can be observed by following the clear and simple directions are stated to be what they are, rather than proved or explained. The authoress, guided by her own experience as a schoolmistress, is probably right in continually pointing out fresh phenomena of interest, which may or may not be immediately forgotten, rather than in wearying the child with difficult arguments which could at best be imperfectly understood, and which would be sure in many cases to awaken a feeling of disgust. In short, Sunshine is a kindergarten and not a school.

Simple and homely language is employed with the greatest propriety, but occasionally it tends to be vague or even to produce a wrong impression. One or two actual mistakes may be referred to in order that they may be corrected in a future edition.

Thus, it is stated that as a rainbow entirely vanishes when the sun is as much as 42° above the horizon. we can never see one at noon. "In the summer" should obviously be added. The reader is told to spin a top carrying a disk painted half yellow and half blue and he will see green. There is a confusion here between the colour obtained by adding two colours as by spinning, and that which is the result of mixing pigments. As is well known, green is not produced under these circumstances, but white or nearly white. The four chapters on soap bubbles, which contain much that is sure to please, are supplemented by some special instructions, which, however, are not quite correct. Fig. 167 is an illustration of an experiment purporting to measure the surface-tension of a soap bubble by the depression of the water level in a quill tube dipping into a glass of water. As the bubble is drawn much larger than the two hands, the pressure within it would not produce any depression of the water below the general level. It would not even visibly affect the capillary elevation. Then it is stated that the surface-tension of pure water is 16·62 grains per square inch. It is, as a fact, a little over three grains per linear inch. The confusion becomes greater in the passage, "We know exactly how much energy it (the elastic film of water) has—16·62 grains per square inch. A tube of 1-inch bore will lift up 16·62 grains of water."

There is one serious fault in the book. Serious because an experiment is described as though it were being performed to an audience which is not only impracticable and impossible, but which would require in a soap-film a property different in kind to that which it possesses. A school-slate frame with one end removed is hung up so that the remaining end is uppermost. A knitting-needle is cut of such a length that it will slide freely in the groove made to hold the slate. From the knitting-needle a pill-box is hung by threads. The object is to weigh a letter. A soap-film is spread over the frame as far as the knitting-needle.

"See how the film is stretching, the knitting-needle is bringing it down like a blind. Now we place a letter in the balance. I know that it weighs just half an ounce, so I can mark on the slate-frame with my blue pencil the place where the knitting-needle stops for half an ounce. I see I was not mistaken in what would take your fancy! I will hang it up here. You shall make one for yourselves, and spend what time you please with it. You will not then easily forget how elastic the film is."

Now the surface tension of a soap film is so small that if the knitting-needle and pill box weighed nothing the slate frame chosen must have been eight or nine feet across, and the knitting-needle the same length; or if the letter and the pill box weighed nothing the knitting needle, if of steel, must have been a great deal finer than any in ordinary use. But even if the experiment were being performed on a minor planet, instead of at Manchester, where with diminished gravitation the half-ounce knitting-needle and pill box would only just be sufficient to balance the tension of the soap film, the description would give the false impression that like a metal or other spring the tension of the soap film increases as the film is stretched, and so is able to rest steadily at some point which depends on the stretching weight. One obviously invented experiment described with all the circumstance and detail that this is, is sufficient to shake one's faith in the genuineness of other demonstrations.

C. V. B.

STRETTON ON THE LOCOMOTIVE.

The Locomotive Engine and its Development. By Clement E. Stretton, C.E. (London: Crosby Lockwood and Son, 1892.)

THE author of this work is well known to the railway world as one who has long taken a great interest in everything pertaining thereto. No one probably has a better knowledge of the history and development of the locomotive. It is with much pleasure we welcome the volume before us. The author very properly gives to Trevithick the name of "Father of the Locomotive," he having used high-pressure steam, the smooth rail, and the blast pipe, some years before either Hedley or Stephenson began to experiment. It is a pity so many men connected with the early progress of the locomotive should have been lost to fame; all did their share—the few only have been handed down to posterity. William James, for instance, certainly should not be forgotten, he having had a large share of the work in proving the locomotive to be a suitable machine for hauling trains, as against the system of fixed engines and rope haulage, and to him is largely due Stephenson's success on the Liverpool and Manchester Railway.

Richard Trevithick was born April 13, 1771, in the parish of Illogan in Cornwall. He was a mechanical genius in many ways. His first engine was made in the year 1803. This engine ran on four wheels, the boiler was arranged horizontally and had a wrought iron return fire-tube; the cylinder was 8¼ inches in diameter, and the piston had a stroke of 4 feet 6 inches. It was arranged horizontally, the crosshead driving a shaft in front of the boiler by means of a return connecting-rod. This shaft carried a heavy flywheel, and was connected to the carrying wheels of the engine by means of spur gearing. The exhaust steam was discharged into the chimney, ensuring an efficient supply of steam.

In the year 1808 Trevithick laid down a circular railway in a field which now forms the southern half of Euston Square. The locomotive exhibited had a vertical cylinder, the crosshead being coupled direct to the hind pair of wheels. This engine weighed about ten tons, and ran at an approximate speed of ten to twelve miles per hour. From these data it will be at once seen that Trevithick was before either Hedley or Stephenson with the invention of the locomotive engine, since both Hedley's and Stephenson's experiments date from the year 1813.

The volume under notice is full of historical data having reference to these early experiments. The author has taken great pains in arranging the matter. Further on in the book, chapter iii., another most interesting subject is dealt with. "The Battle of the Gauges" will long be remembered by engineers. The standard gauge of railways in this country is 4 feet 8½ inches, measured between the heads of the rails. This peculiar dimension appears to have been originally due to the tramways in use at the collieries where the original experiments were carried out by Stephenson and others, and was adopted for the railways when first projected and locomotives used. The great exception to this standard was the seven-feet gauge of the Great Western Railway. This railway, when projected by Mr. Brunel, was intended to eclipse the narrow-gauge of railways, both in speed and comfort when travelling. This competition, however, is claimed by the author as having been the means of hastening the growth and perfecting the locomotive. Looking at the question from the present day, the 4 feet 8½ inch, or standard gauge, is certainly too narrow; the power of the locomotive has gradually been increasing since Stephenson's day, and a point will soon be reached when radical changes must be made in locomotive design, in order to increase the power still more. On the other hand, the now obsolete seven-feet gauge of Brunel was too large. The Indian engineers have adopted the gauge of 5 feet 6 inches for the standard of that country. This dimension appears to be a "happy mean," and one with which locomotive engineers may revel in large journals and free steam and exhaust ports in locomotives fitted with inside cylinders.

It is amusing to read that American engines commenced their competition with the English engine in the year 1840, when some were imported to work the trains up the Lickey incline of one in thirty-seven on the Birmingham and Gloucester Railway. These engines were made by Messrs. Norris and Co., of Philadelphia, weighing slightly under eleven tons. The author tells us they thoroughly beat the English engine of that day doing this particular service.

Every locomotive engineer knows what the Stephenson link motion is—the apprentice in his first year generally prides himself on having mastered its details; yet, for all this, the author tells us to call this old friend by another name! It seems that this gear is really due to Mr. William Howe, an employé of Messrs. R. Stephenson and Co., and was adopted by them and first fitted to an engine for the North Midland Railway in the year 1842. It may here be noted that the question of valve gear generally is not sufficiently described or illustrated in this volume. The index contains several references, but these are very superficial. This becomes all the more apparent when the Joy valve gear is fully described and illustrated, besides a diagram showing results of working.

The Joy valve gear is in the opinion of many an unsuitable gear for a locomotive. It must be evident that any gear which derives its valve motions principally from the vertical movements of the connecting-rod cannot give a good distribution of steam, for the reason that the vertical movements of the connecting rod are affected by those of the driving-axle. The driving-axle is not always in the same position as regards the frames and cylinders owing to the undulations of the road, the oscillation of the engine, and the varying condition of the springs; a movement of half-an-inch above and below the normal position of the driving-axle is quite within the limits of actual practice. This movement is sufficient to affect the true movement of the valve; indeed, it is enough to destroy the lead either on the front or back ports as the case may be. Besides this objection, the Joy gear has nominally a uniform lead for all degrees of expansion, whereas it is usually considered necessary to increase the lead for higher grades of expansion and speed of engine. Some locomotive engineers are willing to risk this defective steam distribution in order to take advantage of the undoubted improvements in design the adoption of this valve gear allows. These mainly consist in the increase in length of the driving-axle bearings for engines with inside cylinders, there being no eccentrics to find room for between the crank webs. The cylinders can be consequently placed closer together, and the steam chest arranged either above or below the cylinders, as the case may be, without the use of rocking shafts or intermediate gear.

Chapter IV. deals with modern locomotives for main line trains. Many well-known engines are illustrated and described, and we naturally find the Compound Locomotives of Messrs. Worsdell and Webb included in the number. The author evidently is not enamoured with the compound locomotive, saying that "facts" are in favour of the simple engine. It is here to be noted that no locomotive superintendent in this country, excepting the patentees of the respective systems, has adopted the compound system. What this is due to is uncertain, because the two-cylinder type of compound locomotive known as the Worsdell system has certainly given good results in India and other countries, comparing favourably with the simple engine. The "Gladstone" locomotive, designed by the late Mr. William Stroudley, is among those illustrated. This raises the interesting question as to the wisdom of using large leading coupled wheels for express work; many engineers prefer a bogie in front, deeming it safer. But when the London and South Western Railway practically copy Mr. Stroudley's arrangement of wheels in their latest engines for mixed traffic, one is apt to be surprised at the change coming from the "bogie" head quarters, and to surmise that anything will do. There is, however, nothing new in the adoption of large leading coupled wheels; many engines were running in India of this design before Mr. Stroudley adopted it, and the whole question can be narrowed down to the comparative life of tyres under different types of engines; there can be no doubt that a four-wheeled bogie or a Bissel truck in front saves the tyres of the leading coupled wheels, a larger mileage being obtained from them before they require to be returned.

Chapter V. includes a description of the sand blast arrangement for sanding the rails to prevent the slipping of the driving wheels. This apparatus, small as it is, has left its mark on the design of express locomotives. The single engine has again come to the front for express work with marked success, the latest design of Midland and Caledonian engines being examples.

This volume taken as a whole is most interesting, and should be of value to all connected with the railway system of this country as a book of reference.

N. J. Lockyer.

OUR BOOK SHELF.

Sketches of British Insects. By Rev. W. Houghton, M.A., F.L.S., M.S.L. (London: O. Newmann and Co., 1892.)

It is satisfactory to find that there is sufficient demand for elementary books on entomology to render necessary a new edition of Mr. Houghton's "Sketches of British Insects;" and for those who, as dwellers in the country, wish to gain some insight into the insect life around them few better books could be found. The differences between the several orders of insects and the main distinctions of the families are plainly and intelligibly set forth, though in a few instances the definition of terms and sections is somewhat faulty; thus, "Arthropod" would be more fitly translated "with jointed feet" instead of "with feet at the joints," and the numerous exceptions are not enough insisted on, there being for instance many insects with aquatic respiration and crustacea with aerial. In Lepidoptera the tongue is often completely absent, whilst in butterflies the forelegs are never wanting, as stated, though in certain families they are rudimentary in both sexes or in the male only, and again the two pairs of spurs on the hind tibiæ are present in the vast majority of moths and also in many skippers. The insects selected for description are well chosen, either as being conspicuous and typical of their families or as illustrating by their peculiarities some principle of adaptation to surroundings, though in many cases the classification is not according to modern ideas; thus, the clearwings (*Sesia*, &c.) have no affinities with the beehawks (*Hemaris*), which belong to the *Sphinges*: and the snouts (*Hypena*) are *Noctues* not *Pyrals*. The account in the Introduction of the structure and metamorphoses is especially simple and clear, and the small volume is on the whole an admirable sketch of British insect life, though the coloration of the plates might have been made much less crude without adding materially to the cost of production.

The Birds of Lancashire. By F. S. Mitchell. Second Edition. Revised and Annotated by Howard Saunders. (London: Gurney and Jackson, 1892.)

We are glad to welcome a new edition of this book, which we reviewed shortly after the publication of the first edition Nature, vol. xxxii. p. 241). The task of preparing a new edition (in the absence of Mr. Mitchell from England) was undertaken by Mr. Howard Saunders, and it is scarcely necessary to say that he has discharged his duty thoroughly. He has no personal connection with Lancashire, but he has had much help from local authorities, especially from Mr. R. J. Howard, of Blackburn; and with their aid he has brought the book, as far practicable, up to date. Several species have been added to the list, and there is a new index.

Borneo: Its Geology and Mineral Resources. By Theodor Posewitz. Translated from the German by Frederick H. Hatch. (London: Edward Stanford, 1892.)

The original work, of which this is a translation, has been reviewed in Nature (vol. xl. p. 49), so that it is unnecessary now to do more than record the fact that an English rendering of the book has been published. Dr. Hatch has done his work most conscientiously, and the translation is likely to be much appreciated by students of geology and mineralogy, and by all who have any reason for being specially interested in the material resources of Borneo.

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 intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

"A New Course of Chemical Instruction."

I am much interested in the article in Nature for September 29, entitled "A New Course of Chemical Instruction," especially as the writer, in the criticism of the book in question, whilst thinking that the method there advocated has theoretically more to recommend it than any other, doubts whether practically the time required is not an insurmountable obstacle.

For four years I have been able to teach beginners in Chemistry on a method very closely allied to the one here proposed, that is to say, one in which no experiment is performed without a definite object in view—the final object being the solution of a given problem and no idea being given to the pupil of what the result will be, and I am glad to be able to say that the time required is *not* such a serious drawback as might be supposed, whilst the intense interest aroused and the training in scientific methods of work amply compensate for the slower acquirement of chemical facts.

I have not the advantage of being acquainted with Mr. Castell-Evans' book, so that I am not quite sure how nearly my work would agree with his course, but the fundamental principle is undoubtedly the same, and is the one laid down by Dr. Armstrong in the report of the British Association Committee on Chemical Teaching, where he advocates the teaching of Chemical method rather than Chemical facts.

What generally appals the beginner in Chemistry is the multitude of facts to be remembered; it seems a mere question of memory, and in consequence so dull and uninteresting, that the explosion or "burst up" is the one point to be looked forward to in the lesson. By this new method the pupils themselves are put into the position of discoverers, they know why they are at work, what it is they want to discover, and as one experiment after another adds a new link to the chain of evidence which is solving their problem, their interest grows so rapidly, that I have seen at a demonstration lesson a whole class rise to their feet with excitement when the final touch was being put to the problem which it had taken them three or four lessons to solve. Facts learned with so much interest are not forgotten and form a solid basis which it is true is slowly laid, especially at first, but it is interesting to see how much more quickly and easily later facts are assimilated, each one fitting itself in with the knowledge already acquired, and even when it becomes a question of reading the account of work which it is impossible for the student to repeat for himself, the methods adopted are quickly understood and easily remembered, because the general methods of analysis and synthesis have, in an easy form, not only been used, but discovered by the student himself.

This method of course breaks down where an elaborate examination syllabus is imposed upon the beginner from the outset, and even where this is not the case, every teacher must adapt the method to his own conditions, only and always keeping the fundamental principle in view.

For the beginner in Chemistry whether he is later to specialise in this subject or not, experience has convinced me that the teaching of facts must give way to the teaching of method if a sound basis is to be laid in chemical science, whilst the subject opens the whole question of the value of Chemistry teaching from the educational point of view. GRACE HEATH.

The Temperature of the Human Body.

THERE is a problem partly physiological and partly physical which I shall be grateful if any reader of NATURE can throw light upon.

1. *The physiological.*—I am assured by medical opinion in which I have confidence that the temperature of the human body is invariable from pole to equator of the earth. The question I want to ask, assuming this to be true, is this : What is the action in the body which exactly and everywhere counterbalances the radiation and conduction of heat in the one case from the body and in the other to the body? I thought at first that perspiration might have something to do with it, but my medical authority assures me that at the equator a man who perspires freely has exactly the same temperature as one that perspires little, although the former will be in good and the latter in bad health.

2. *The physical.*—Treating the animal as a heat engine, one is apt to think of the source of heat as the animal heat engendered by the combustion going on in his frame, and the refrigerator as the surrounding air at lower temperature—in the experience of most of us. The animal then does work at the expense of this heat during its transfer from source to refrigerator, as in an ordinary engine. On the other hand, the animal in equatorial regions must, if the physiological statement above be a fact, be often the coldest of surrounding bodies. Does he also do work at the expense of the heat of combustion in his body, and if so is this vital action an exception to the second law of thermodynamics? If not, does he do work at the expense of the heat which is conducted into his body from hotter surrounding bodies, which heat, when he is doing no external work, still does not raise the temperature of his body?

Rugby. L. CUMMING.

Comet II. 1892 (Denning, March 18).

THIS comet is still a tolerably easy object in my 10-inch reflector and will doubtless continue to be visible during the greater part of the ensuing winter. It is now approaching the earth, and its brightness is increasing slightly. During the next two months it will traverse Orion.

I observed the comet on September 30, when it was in the same field as the 6th mag. star Piazzi VI. 144 (Lalande, 12546). By differential observations with that star I found the place of the comet to be

	G.M.T.	α.	δ.
	h. m.	h. m. s.	° ′
1892, Sept. 30 ...	12 50 ...	6 25 51 ...	+14 11.

The theoretical brightness, as given in Schorr's ephemeris, was 0·62, but to my eye the comet seemed quite as plain as in March last. The nucleus was, perhaps, not so distinct, but the surrounding nebulosity appeared to be more extended than on previous occasions.

The comet will be close to ζ Orionis (the southernmost star in the belt) about November 14, and passes very near β Orionis (Rigel) on November 30. W. F. DENNING.

Bristol, October 2.

Cirro-stratus.

A RATHER perfect example of one variety of this cloud was seen here in the afternoon of September 27. A rapid fall of the barometer until 5 A.M., accompanied by a high wind, had been followed by a steady rise, the wind moderating some hours later. At 2 p.m., with a westerly light air, the sheet of cirro-stratus which overspread the sky appeared in the form of a series of very perfect undulations, stretching nearly north and south. These were about fourteen in number, crowded together towards the east. The lower surface of the sheet was sharply defined, and could be followed with ease in its successive rise and fall. The cloud-filaments could be also traced, preserving their perpendicularity to the wave-fronts and conforming to the undulations of the lower surface with a closeness which I had not before observed, although sheets of cirro-stratus are common here. The whole system was drifting slowly to the east.

J. PORTER.

Crawford Observatory, Queen's College, Cork.

A New Habitat for Cladonema.

WILL you kindly allow me through your columns to note a habitat for this genus not given in Allman or Hincks. Several weeks ago I received some sponge from Mr. Sinel, of Jersey, and on examining it with a hand-lens detected four polypites of Cladonema, one, at least, of which is still alive.

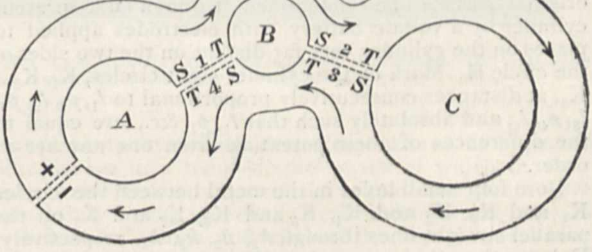
HENRY SCHERREN.

5 Osborne Road, Stroud Green, N.

TO DRAW A MERCATOR CHART ON ONE SHEET REPRESENTING THE WHOLE OF ANY COMPLEXLY CONTINUOUS CLOSED SURFACE.

IF a solid is not pierced by any perforation, its surface is called simply continuous, however complicated its shape may be. If a solid has one or more perforations, or tunnels,[1] its whole bounding surface is called "complexly continuous"; duplexly when these is only one perforation ; $(n+1)$-plexly when there are n perforations. The whole surface of a group of n anchor-rings (or "toroids") cemented together in any relative positions is a convenient and easily understood type of an $(n+1)$-plexly continuous closed surface.

Let the diagram represent a quadruplexly continuous closed surface made of very thin sheet metal, uniform as to thickness and homogeneous as to quality throughout. To prepare for making a Mercator chart of it, cut it open between perforations C and B, B and A, A and outer space, in the manner indicated at $\overset{2}{\underset{3}{=}}$, $\overset{1}{\underset{4}{=}}$, and $\pm$. Apply infinitely conductive borders to the two lips separated by the cut at $\pm$, and apply the electrodes of a voltaic



battery to these borders. By aid of movable electrodes of a voltmeter trace, on the metallic surface, and a very large number ($n-1$, of equidifferent equipotential closed curves between the + and − borders. Divide any one of these equipotentials[2] into parts each equal to the

[1] A "hole" may mean a deep hollow, *not* through with two open ends. The word "tunnel" is inappropriate for the aperture of an anchor ring. Neither "hole" nor "tunnel" being unexceptionally available, I am compelled to use the longer word "perforation."

[2] Two sentences of my previous article ("Generalisation of Mercator's Projection") in § 3, and in last paragraph but one, are manifestly wrong, and must be corrected to agree with the rule given for dividing into infinitesimal squares, in the present text.

infinitesimal distance perpendicularly across it to the next equipotential on either side of it; and through the divisional points draw curves, cutting the equipotentials at right angles. These curves are the stream lines. They and the $(n+1)$ closed equipotentials (including the infinitely conductive borders) divide the whole surface into $n\ m$ infinitesimal squares, if m be the number of divisions which we found in the equipotential. The arrows on the diagram show the general direction of the electric current in different parts of the complex circuit; each arrow representing it for the thin metal shell on either far or near side of the ideal section by the paper.

Considering carefully the stream-lines in the neighbourhoods of the four open lips marked in order of the stream 1, 2, 3, 4, we see that for each of these lips there is one stream-line which strikes it perpendicularly on one side and leaves it perpendicularly on the other, and which I call the flux-shed-line (or, for brevity, the flux-shed) for the lip to which it belongs. The stream-lines infinitely near to the flux-shed, on its two sides, pass infinitely close round the two sides of the lip, and come in infinitely near to the continuation of the flux-shed on its two sides. Let F_1, F_2, F_3, F_4 (not shown on the diagram) be the points on the + terminal lip from which the flux-sheds of the lips 1, 2, 3, 4 proceed; and let G_1, G_2, G_3, G_4, be the points at which they fall on the − lip. Let S_1, T_1, S_2, T_2, &c., denote the points on the four lips at which they are struck and left by their flux-shed-lines.

Let p_1, l_1, p_2, l_2, p_3, l_3, p_4, l_4, p_5 be the differences of potential from the + lip to S_1, from S_1 to T_1, T_1 to S_2, ... S_4 to T_4, and T_4 to the − lip. Measure these nine differences of potential. We are now ready to make the Mercator chart. We might indeed have done so without these elaborate considerations and measurements, simply by following the rule of my previous article; but the chart so obtained would have infinite contraction at eight points, the points corresponding to S_1, T_1, ... S_4, T_4. This fault is avoided, and a finite chart showing the whole surface on a finite scale in every part is obtained by the following process.

Take a long cylindric tube of thin sheet metal, of the same thickness and conductivity as that of our original surface; and on any circle H round it, mark four points, h_1, h_2, h_3, h_4, at consecutive distances along its circumference proportional respectively to the numbers of the m stream-lines which we find between F_1 and F_2, F_2 and F_3, F_3 and F_4, F_4 and F_1 on the + lip of our original surface. Through h_1, h_2, h_3, h_4 draw lines parallel to the axis of the cylinder.

Let now an electric current equal to the total current which we had from the + lip to the − lip through the original surface be maintained through our present cylinder by a voltaic battery with electrodes applied to places on the cylinder very far distant on the two sides of the circle H. Mark on the cylinder eight circles, K_1, K_2... K_8, at distances consecutively proportional to $l_1, p_2, l_2, p_3, l_3, p_4, l_4$, and absolutely such that l_1, p_1, &c., are equal to the differences of their potentials from one another in order.

Bore four small holes in the metal between the circles K_1 and K_2, K_3 and K_4, K_5 and K_6, K_7 and K_8 on the parallel straight lines through h_1, h_2, h_3, h_4, respectively. Enlarge these holes and alter their positions, so that the altered stream-lines through h_1, h_2, h_3, h_4 (these points supposed fixed and very distant) shall still be their flux-sheds. While always maintaining this condition, enlarge the holes and alter their positions until the extreme differences of potential in their lips become l_1, l_2, l_3, l_4, and the differences of potential between the lips in succession become p_2, p_3, p_4. In thus continuously changing the holes we might change their shapes arbitrarily; but to fix our ideas, we may suppose them to be always made circular. This makes the problem determinate, except the distance from the circle H of the hole nearest to it, which may be anything we pleased, provided it is very large in proportion to the diameter of the cylinder.

The determinate problem thus proposed is clearly possible, and the solution is clearly unique. It is of a highly transcendental character, viewed as a problem for mathemetical analysis; but an obvious method of "trial and error" gives its solution by electric measurement, with quite a moderate amount of labour if moderate accuracy suffices.

When the holes have been finally adjusted to fulfil our conditions, draw by aid of the voltmeter and movable electrodes, the equipotentials, for p_1 above the greatest potential of lip 1, and for p_5 below the least potential of lip 4; and between these equipotentials, which we shall call f and g, draw n-1 equidifferent equipotentials. Draw the stream-lines, making infinitesimal squares with these according to the rule given above in the present article. It will be found that the number of the stream-lines is m, the same as on our original surface, and the whole number of infinitesimal squares on the cylinder between f and g is $m\ n$. Cut the cylinder through at f and g; cut it open by any stream-line from f to g, and open it out flat. We thus have a Mercator chart bounded by four curves cutting one another at right angles, and divided into $m\ n$ infinitesimal squares, corresponding individually to the $m\ n$ squares into which we divided the original surface by our first electric process. In this chart there are four circular blanks corresponding to the lips 1, 2, 3, 4 of our diagram; and there is exact correspondence of their flux-sheds and neighbouring stream-lines, and of the disturbances, which they produce in the equipotentials, with the analogous features at the lips of the original surface as cut for our process. The solution of this geometrical problem was a necessity for the dynamical problem with which I have been occupied, and this is my excuse for working it out; though it might be considered as devoid of interest in itself. KELVIN.

THE RECENT ERUPTION OF ETNA.[1]

THE southern flank of Etna has been the site of three consecutive eruptions, remarkable for the diversity of the phenomena they presented.

On March 22, 1883, after several violent shocks of earthquake, the ground was rent open in a N.E. and S.W. direction, almost on the continuation of the big rift formed in the eruption of 1879, and near Monte Concilio a most interesting eruptive apparatus was formed. Very quickly, however, the eruption was arrested, but the eruptive energy had not had sufficient vent, as evidence of which were the frequent shocks which followed it and persisted, until on March 18, 1886, the ground was again split open as a prolongation of the rift of 1883, giving rise to an imposing eruption, during which an enormous quantity of lava was poured forth. This eruption from the very beginning manifested a great explosive force. The fragmentary materials were projected to an extraordinary height from several craterets formed along the rift, most of which, however, soon became quiet and were buried by the ejectamenta of the others, remaining alone the one twin crater now called Monte Gemmellaro. After this eruption the geodynamic phenomena and the volcanic activity at the central crater remained exceedingly feeble up to the last few days, so that this actual eruption did not present any grand display of premonitory phenomena.

On the evening of July 8, at about 10.30, the central crater of Etna began to send up a dense column of vapour, charged with dust, lapilli, and large rock fragments, which rose as an imposing mass with the

[1] This paper was written in Italian, and sent as a letter to Dr. H. J. Johnston-Lavis, who has kindly translated it for NATURE, as requested by the author.

characteristic pine-shape of explosive eruptions, and illuminated by lightnings.

After half an hour this phenomenon ceased, and the smoke-plume was swept away by the higher currents of the atmosphere. I was able to ascertain in my excursion to the summit of Etna, in company with Mr. Rudler, curator of the Museum of Practical Geology of London, that the central crater was much modified by the short eruption. It presented two mouths, separated by a partition, whilst its upper edge was much broken down, so that it was enlarged. The ejected materials were composed of fragments of very much altered lavas that fell chiefly to the westward. During the night the ground was in a state of tremor, and at 2.45 a.m. of the 9th, a strong shock of earthquake was felt all over the Etnean region, producing slight damage to the walls of buildings.

Towards 1.20 p.m., without any further shock sensible in the inhabited regions, the southern flank of Etna was which is to the south of the new craters, it divided in two principal branches and precipitated itself on the plain from which rises Monte Gemmellaro, forming three cascades of living fire. It here spread out, and the two branches, directing their course to the south, threatened Nicolosi, Belpasso, and Pedara. The more eastern ramification, when it reached the neighbourhood of Monte Albano, began to slow down and was already on the 12th advancing about two metres per hour, but increasing the breadth of its front and its thickness. On the other hand the western branch, which was invading the cultivated land, advanced in the steeper ground over fifty metres the hour, as I observed in my first visit on July 11. This stream was of a bright red colour, slightly covered by scoria. Near Monte Concilio it had filled up a valley, assuming a thickness of over 40 m. From Monte Ardicazzi we had presented to our view an immense expanse of fire from which rose crests and hills all in-

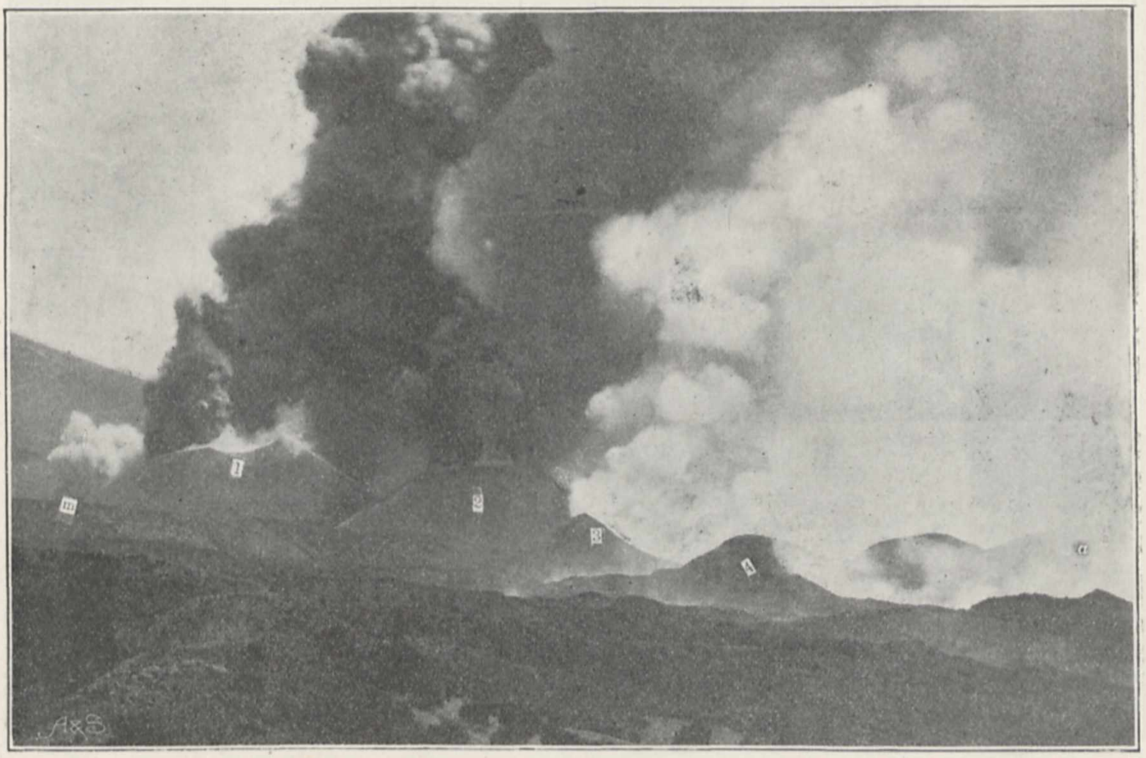


FIG. 1.—Taken by Sig. Ledrù on July 17. (No. 1, 2) are craters No. 1 and 2. (No. 3 and 4) craters No. 3 and 4 in process of formation.—(*m*) Crateriform vent at the north base of crater No. 1.—(*a*) Monte Nero about one km. west of the craters.

rent open, and I could observe from Acireale a dense curtain of smoke rush up in great vortices, accompanied by continual rumblings. Towards evening one could see that the lava had advanced very rapidly in a southern direction. At the upper part it was observable that several jets, arranged in a linear manner, of fragmentary materials were being shot up to a great height, especially at three main points on the new and great rift. The explosive force of this eruption was much less than that of the eruption of 1886, in which the fragmentary ejecta were shot up to a height of 1200 metres, whilst in the present case the height rarely exceeded 500 metres. This fact depends on the great altitude and the great size of the new fissure, which afforded a free escape for the energy of the volcano, and gave forth a much greater quantity of lava. The lava in less than three days travelled more than four kilometres, and having surrounded Monte Nero, candescent, divided by deep depressions. It appeared like the sea in a tempest, the waves of which in their fury were suddenly petrified. From the crests were constantly being detached fresh incandescent masses which rolled down and choked the depressions, whilst new gushes raised the masses of scoria into new hills of fire. Amidst the phonolitic noise of the lava in movement, I noticed gigantic puffings produced by the escape of the vapour of H_2O, which, accumulating amidst the mass of the lava, formed gigantic bubbles which rose and burst, allowing the escape of the compressed gas.

The eruption was very active during the following days with short intervals of diminution or marked increase. Remarkable phenomena were the blasts which shook the doors and windows at Nicolosi, Acireale, and Catania, and, at localities nearer the point of eruption, even the walls.

On July 16 I started again, with my brother Giovanni, to approach the site of eruption. From Monte Caprioletto, which is about 1200 m. distant, we could observe not only the three principal craters above mentioned, but also two others lower down, which so far had not grown to any important size.

Approaching still farther, we stopped at about 300 m. off on the west, on a plain upon which grows the *Astragalus Siculus*, the bushes of which are now covered by large lapilli, and in part are burnt. The crater, which for brevity we will call No. 1, gave forth large and continual bursts of dust and scoria from its summit, and also from other points on its northern wall, at the base of which issued a jet of light-grey vapour, which came from a little imbutiform crater separated from the main one by a partition of small size; from this were ejected a little dust and occasionally stones. The explosions of No. 1 were not accompanied by loud noises (*boati*, *bellowings*), but by strong and continual roarings like the sea in a tempest. Crater No. 2, more regular in form, gave forth frequent eruptions of dust, with many incandescent projectiles. In the moments of calm between one explosion and another, a slight white vapour escaped. The first burst of the explosion might be compared to a gigantic pointed jet preceded by black dust and sand, which rose with great rapidity in consequence of the great ascensional velocity, which was gradually impeded by the resistance of the air; then the column of black smoke charged with dust began to open out the immense vortices of compressed vapour which, always rising, assumed an imposing and characteristic aspect. The pieces of scoria were followed by a trail of dust both in their rise and fall, and when they struck the flanks of the mountain as they rolled down, they raised a cloud of dust and gave forth a characteristic sound. When they were numerous the mountain became all covered by a yellow dust.

Also in this last crater the explosions took place from several points of its funnel-shaped cavity; and we saw, at about mid-day of the 17th, much of its southern side destroyed by several bursts that took place from that point.

Both of these craters, already of considerable height, had an elliptical base, and specially No. 1, the maximum diameter of which is in the direction of the great rift, along which they are distributed.

The third crater, which we will call No. 3, adjoining the preceding one, presents a large depression to the south. It gave forth frequent bursts of incandescent lava fragments, with a constant noise resembling the constant discharge of much musketry, and accompanied by yellowish-white vapours. The emission of dust was rare, and only occurred when the eruptive bursts scored the north side of the crater. The fragments of incandescent lava, which in this crater were not accompanied by a trail of dust, often were torn asunder in the air, being reduced to fragments.

FIG. 2.—By Sig. Ledrù on August 19, at 100 m. to the north-east of the craters. (*S*) Crater of August 11. (*d*) Crater to the west which was in activity only on July 9. (1) Crater No. 1.

The discharge of smoke from this crater occurred from the highest part, then there was the point at which occurred the numerous explosions of lava, then another jet of smoke, in its turn followed by another point lower down, from which occurred the explosions of the incandescent projectiles that gradually formed a crater, which we will distinguish as No. 4.

In general, while we were moving about to the westward of the craters on the morning of the 17th, the eruption was exhibiting comparatively little energy. Gradually, however, the explosions increased in violence, and the ejecta became more numerous. It is worthy of notice that the smoke, according to the place whence it issued was white, blue, light or dark grey, black, yellow, and even iridescent. Approaching nearer the craters, we attempted to encircle them on the north, when we found numerous little fissures in the ground in a direction approximately parallel to that of the main rift. These, often over a metre in breadth, are choked by the loose materials forming the surface, and in part obstructed by the loose materials forming their sides. Higher up we found a wide cleft, which, starting from a higher point, was prolonged downwards towards the craters and was lost beneath the lava. Upon this fissure were arranged a series of crateriform elevations, some of which were extinct, and others still presenting a little solfataric action. On July 9, at the commencement of the eruption, lava and fragmentary ejecta also issued by this cleft, but it seems, the same day, to have become obstructed, and the tongue of lava which menaced the Casa del Bosco stopped, and the eruptive phenomena were diverted to the other more eastern fissure.

It is absolutely impossible to accept the statement that this cleft represents the fire vents of the eruption of 1766, and that the solfataric phenomena which the cleft now exhibits are only due to the near vicinity of the new volcanic outlet, for—putting aside the fact that in visits anterior to the present eruption I had never found any sign of such, and this is confirmed by people accustomed to the locality—it is easy also to be convinced from the nature of the materials composing these craterets. These materials are so new as to leave no doubt as to their origin, and consist, those higher up, specially of blocks of old lava torn from the sides of the cleft; lower down they are principally scoria and other loose materials of recent formation.

Approaching still nearer, we were able to distinguish clearly that amongst the ejected materials of No. 1, besides the number of fragments of molten lava, there are often blocks of a dark grey colour that were already consolidated before their final ejection, which are either projectiles that have fallen back in the crater and have been re-ejected, or are pieces of rock detached from the walls of the volcanic chimney. Certainly from the last source are derived quartzites, which we collected amongst the ejected materials from this crater. This quartzite is semi-vitreous, very similar to that which we collected from the craters of the eruptions of 1883 and 1886. These facts evidently showed that all these three eruptions have traversed similar strata and that all have arisen over the same principal cleft. In fact the new eruptive apparatus formed at the base of the Montagnola about 1900 m. above sea level, lies on the northern prolongation of the rift of 1886, in a plain gently inclined toward the south, and which towards the east presents a marked slope, so that the new craters are much higher on their eastern side. In the great paroxysmal eruptions, and when a large rift opens at the surface of the earth, it is generally the rule that the eruptive mouth from which the lava flows without much explosive force is situated at its lowest extremity. The higher one goes along the fissure the less is the amount of lava that issues, but the greater is the explosive action, which higher still itself in turn diminishes. In the present eruption we have good examples of this. In fact, the small northern crater gave forth only dust, and very few fragments of new lava, and with little energy. No. 1 crater emitted much dust and also much lava; No. 2 more lava than dust, and Nos. 3 and 4 exclusively lava. The materials of the little northern crater (Fig. 3) are for the most part fragments of ancient lava, which lose their predominance in crater No. 1, and gradually disappear as one descends lower and lower. At the same time, as the old lava has a light bluish-grey colour and the fragments of the newer lava are much darker, the different craters exhibit different colours. This difference also depends in part upon the degree of fineness of the materials that compose the craters. In fact the northernmost crater at the beginning

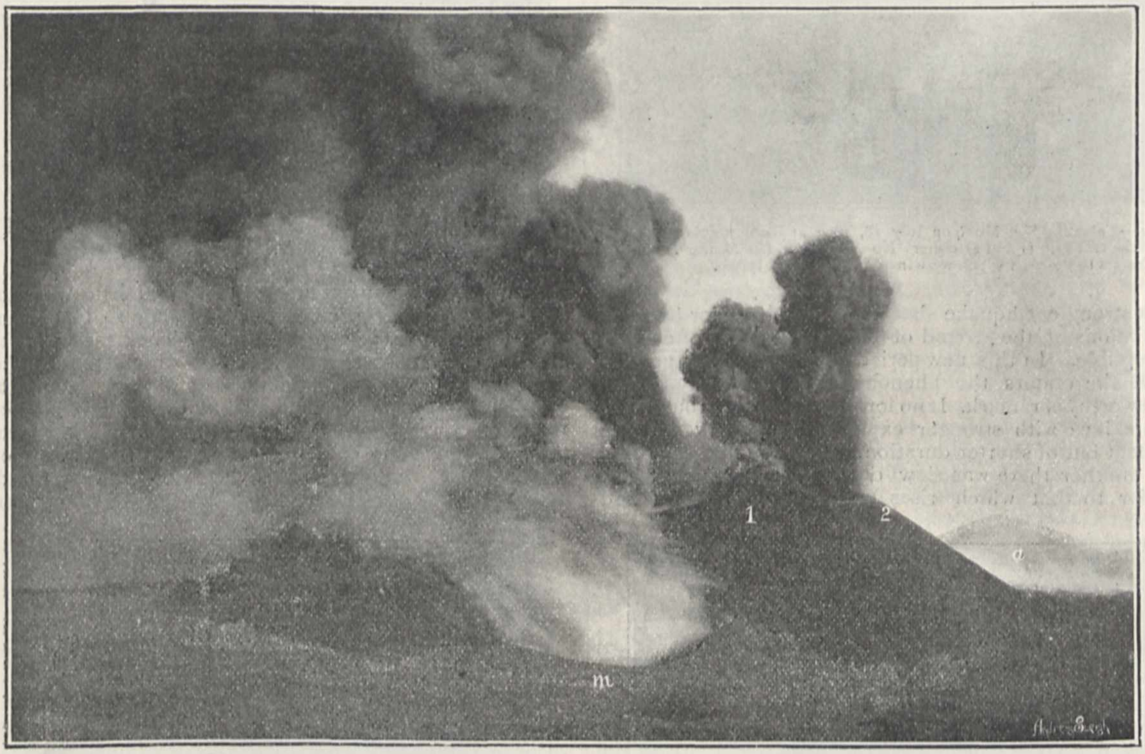


FIG. 3.—Taken by Sig. Modò on July 13, 1892, at 150 m. to the north-west of the craters. Craters No. 1 and 2. (a) Monte Nero. (m) Little northern crater.

of the rift had not sufficient power to eject large materials, but lifted them up and kept them in continual movement, reducing them to fine dust, which was easily carried out by the vapour. No. 3, on the contrary, continually ejected large lumps of lava, often shooting them a considerable distance, whilst Nos. 1 and 2 exhibited intermediate stages, quite confirming what has been said above.

Whilst we were there the eruption increased little by little. The ground commenced to vibrate, and at 3.47 p.m. we

Fig. 4.—Taken by Sig. Modò on July 18, 1892, at 300 m. to the north-west of the craters. (1 and 2) craters No. 1 and 2. (*a*) Monte Nero. (*d*) Craters to the west which were in activity only on July 9.

felt a strong earthquake shock, followed by other frequent oscillations of the ground of less intensity but often very perceptible. In this new period of great activity general to all the craters the phenomena exhibited by No. 2 were worthy of remark. It no longer ejected dust, but pieces of hot lava with stronger explosions, which were more frequent but of shorter duration. Between one explosion and another there was slow evolution of white vapour, similar to that which rises from the fire-mouths and

Fig. 5.—Taken by Prof. Riccò on July 20, west of the craters. (1, 2, 3). craters No. 1, 2, and 3.

surface of the running lava. This floated above the crater, slightly disturbed by the wind, and when an explosion occurred it assumed a curious vibratory movement, rising a little, and then rapidly descending; then immediately was seen the first jet of solid materials, which, in its vertiginous upward course by vortex movement, sucked in the air over the crater edge, and the white vapours were drawn down, so looking as if they were being reabsorbed. This phenomenon, which attracted our attention when I was with you on Stromboli and the members of the Geologists' Association,[1] would show that within crater No. 2 there is pasty lava, which is pushed up by the vapour in it; then the magma swells up, bursts, and the lava falls.[2]

In this parasitic crater of Etna, however, the phenomena were on a much larger scale, as also were the smoke vortex rings which we looked down upon when we were together at Stromboli. Likewise the explosions were far louder, reverberating as a low-pitched roar by the echo of

Fig. 6.—Taken by Prof. Riccò on July 20, to the north-west of the crater No. 1, 2, and 3. (*a*) Monte Nero.

the valleys, and they were audible in all the Etnean region, at Catania, Acireale, Giarre, and farther still for some dozens of kilometres from the craters. The air-shocks that accompanied these reports were very interesting. They represented a large undulation of the air, spreading with great velocity, reaching great distances, and contemporaneous with the audible vibrations.[3] While there, we felt the blow on our bodies, and especially our chests and in the ears; at the Casa del Bosco we detected the shock against the walls, which trembled, and

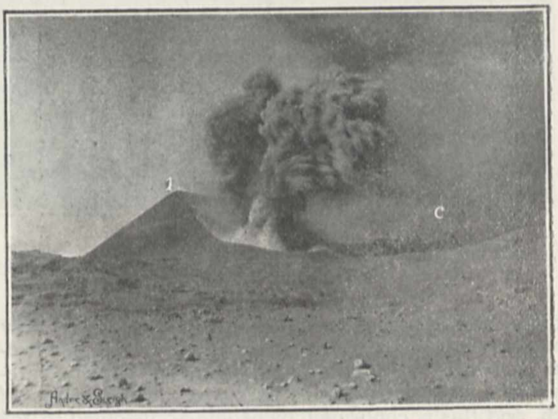


Fig. 7.—Taken by G. Platania from the north-north-east of the craters, July 30, 1892. (1) Crater No. 1. (*c*) Craters which were in activity only on July 9. The craters No. 2, 3, and 4 are hidden behind crater No. 1.

farther off at Catania and Acireale we heard the rattling of the windows and doors, which, strongly shaken,

[1] G. Platania "Stromboli e Vulcano, nel Settembre del 1889. Riposto 1889." This phenomenon I have often observed at Vesuvius, and I quite agree with Signor Platania as to its cause, as I have been able to look into the crater and watch the whole process.—Johnston-Lavis.

[2] The lava in this case is very like the boiling up of a viscous liquid in a long test-tube.—Johnston-Lavis.

[3] I have some doubts about the two mechanical disturbances travelling exactly at the same rate. When blasts are fired in a long tunnel the air-stroke is felt before the sound.—Johnston-Lavis.

give the impression of an earthquake, so that several times the people of these towns have rushed out into the streets. On July 14 I observed in Acireale that the large undulations of the air-blows which were propagated beyond 333 m. per second, like sonorous vibrations, often arrived unaccompanied by noise, and strongly shook doors and windows.

These reports, these air-blows, and the abundant ejection of incandescent lava still further prove that in No. 2 crater there was pasty lava which swelled and burst, as we deduced from its effect on the white vapours.

This period of great activity, in which the thick shower of lava fragments projected from the different craters to great heights, and spread over an area of 500m radius, reached its maximum about midnight, and then gently declined a little. In the same manner the eruption continued during the following days with great energy, but with a very gradual diminution in its intensity, interrupted more or less by strong spasms. The lava continued to advance, but diminished in velocity, while it extended in breadth and depth. The eastern branch very soon stopped, and also the western one, after having continued its destruction of very fertile ground. This having crossed the road known as the St. Leo, finally

Monte Nero. Crater No. 4. Crater No. 3. Crater No. 2. Crater No. 1.

FIG. 8.—Taken by G. Platania on July 30 from the north-east of the craters, No. 4 is still very little, but in part hidden behind a prominence of the ground.

stopped, whilst the new lava that continues to issue forms new ramifications and flows, which pass quite close to the earlier ones, and now actually are in contact with them, increasing the area covered. In the first paroxysm of the eruption the lava issued in great gushes all along the rift. Soon at the upper part commenced the dejection cones, and lower down the fire vents, and the lava flowed in abundance, and with explosions also in points where now are the craters, as, for example, Nos. 3 and 4. Later, when the explosive force had diminished, the lava issued without explosions, almost silently from different vents at the south end of the fissure on which are aligned the craters. These vents, therefore, have during the eruption varied in number and form. Some have assumed the function of dejection craters as occurred in Nos. 3 and 4, which gave passage to much lava as a current. Others have ceased to eject scoria, to send forth only torrents of lava, as, for example, the little mouth to the east of No. 4, the scoria rim of which exists only to the north, of about 20m. high, whilst the south rim has been swept away by the current. Some of the mouths have been refilled by the lava flows, and whilst some have become extinct new ones have been formed.

In the last week of July, crater No. 2 assumed, for some days, a new phase. Its explosions had become rare, long, and very grand, and the large mass of vapour, mixed with dust, brought back to my mind the eruption of Vulcano when we stood on the crater edge and watched and photographed the whole process, and stood our ground amidst showers of bombs and other projectiles (1888–90).[1] By this it lost the beautiful regular truncated cone form that it had at the beginning, and became irregular and broken-down towards the north, like No. 1.

At the commencement of August the eruption already seemed much diminished, craters No. 1 and 2 had ceased to eject stones little by little, gradually becoming blocked, and the enclosed lava was slowly cooling. In fact, on the recommencement of a period of renewed energy, the explosive force could no longer find an escape by them, so that on August 1 a new crater opened in a point higher up where the cleft to the west, which had only acted at the commencement of the eruption, joined another great rift on which the craters were formed. Then on August 9 occurred another violent eruptive spasm, which could not clear away the material that obstructed the craters, but opened a new way, always on the main cleft, between Nos. 1 and 2, and exactly at the north base of the last of these craters. Here a little funnel-shaped depression was formed which for a short time ejected enormous masses. This new crater, however, soon passed into the solfataric stage as Nos. 1, 2, and 3, and there remained in an energetic state of activity only the crater of August 11 and No. 4. That one which on August 21 measured in diameter only about 50 m., and had a height of about 60 m., later became elongated towards the S.S.W., and its grand and beautiful explosions, which I watched quite closely, in company with Mr. Rudler, on August 29, 30, and 31, were specially localized on the southern edge, so that they tended all the more to give it an elongated form on that more western cleft that was only in activity the first days of the eruption. No. 4, meanwhile, which I approached, ascending upon No. 3, gave forth frequent eruptions of hot lava cakes at regular intervals (about fifty per minute), accompanied by globes of yellowish vapour, and a noise similar to that which accompanies the globes of vapour from the locomotive when it commences to move.

By unanimous consent of all the studious inhabitants of Etna, the new craters have been called the Monti Silvestri, in honour of that well-known vulcanologist, the lamented Prof. Orazio Silvestri, who studied our volcano with so much fervour, registered so assiduously every slight disturbance, and described its paroxysms so well and with such originality, that his loss has been deeply felt by all men of science. GAETANO PLATANIA.

14, Via S. Giuseppe, Acireale,
September 7.

NOTES.

THE Harveian oration will be delivered by Dr. J. H. Bridges at the Royal College of Physicians on Tuesday, October 18, at four o'clock.

THE Medical Session in London was opened on Monday, and introductory addresses were delivered in some of the schools attached to hospitals. A particularly interesting and suggestive address was delivered at the Westminster Hospital by Dr. Mercier, who dealt with various aspects of the problems connected with crime, pauperism, and insanity. Sir John Lubbock addressed the students at St. Thomas's Hospital.

ON Friday last Sir George Murray Humphry, F.R.S., delivered an interesting address at the opening of the first session

1 "South Italian Volcanoes," by Johnston-Lavis, Naples, 1891. "I Projettili Squarciati di Vulcano," by G. Platania. (Roma, 1891.)

of the Queen's Faculty of Medicine in connection with Mason College, Birmingham. The union of the two institutions is likely to be of great service both to medicine and to pure science in the Midlands.

A MARINE biological station has been established at Bergen, in Norway, the funds having been raised by private donations and by subscriptions from learned societies. It will be under the control of Dr. J. Brunchorst, and will supply ten places for Norwegian and foreign workers.

WE regret to learn that M. Henri Douliot, who had been commissioned by the French government with a botanical expedition to the western coast of Madagascar, has died there of fever.

DR. B. L. ROBINSON has been appointed Curator of the Herbarium of Harvard University, Cambridge, U.S.A., in succession to the late Prof. Serreno Watson.

MR. WALTER E. COLLINGE, late Assistant-Demonstrator in Zoology in St. Andrew's University, has been appointed to the vacant Demonstratorship in Zoology and Comparative Anatomy and Botany in Mason College, Birmingham.

A CIRCULAR appeal, dated September, 1892, and signed by Mr. E. C. Pickering, Director of the Observatory of Harvard College, has been issued, inviting the wealthy to consider the opportunity offered for a donor of 200,000 dollars "to have his name permanently attached to a refracting telescope, which, besides being the largest in the world, would be more favourably situated than almost any other, and would have a field of work comparatively new." The telescope in question would be placed in the station established by Harvard College Observatory, near Arequipa in Peru, at an altitude of more than eight thousand feet. "During a large part of the year," says Mr. Pickering, "the sky of Arequipa is nearly cloudless. A telescope station having an aperture of thirteen inches has been erected there, and has shown a remarkable degree of steadiness in the atmosphere. Night after night atmospheric conditions prevail which occur only at rare intervals, if ever, in Cambridge. Several of the diffraction rings surrounding the brighter stars are visible, close doubles in which the components are much less than a second apart are readily separated, and powers can be constantly employed which are so high as to be almost useless in Cambridge. In many researches the gain is as great as if the aperture of the instrument was doubled. Another important advantage of this station is that, as it is sixteen degrees south of the equator, the southern stars are all visible." The circular continues: "The planet Mars, when nearest the earth, is always far south. The study of the surface of this and of the other planets is greatly impeded by the unsteadiness of the air at most of the existing observatories. Even under the most favourable circumstances startling discoveries—relating, for example, to the existence of inhabitants in the planets—are not to be expected. Still, it is believed that in no other way are we so likely to add to our knowledge of planetary detail as by the plan here proposed." We venture to hope that the wealthy donor for whom Harvard is looking will soon be found.

BARON LÉON DE LENVAL, of Nice, offers a prize of 3,000 francs to the inventor of the best application of the principles of the microphone in the construction of a portable apparatus for the improvement of hearing in deaf persons. Instruments for competition should be sent to Prof. Adam Politzer, or Prof. Victor von Lang, Vienna, before December 31, 1892. The prize will be awarded at the Fifth International Otological Congress at Florence in September, 1893. If no instrument is judged worthy of the prize, the jury reserve the right of announcing another competition, unless Baron Lenval decides to dispose of the prize otherwise. The following are the members of the jury:—Prof. Adam Politzer (President), and Prof. Victor v. Lang, Vienna; Dr. Benni, Warsaw; Dr. Gellé, Paris; Prof. Urban Pritchard, London; Prof. St. John Roosa, New York; Prof. Grazzi, Florence.

THE weather during the past week has been much disturbed by several depressions, which have caused heavy rainfalls over the whole of the kingdom, with hail and thunderstorms in many places. On the morning of September 30 the amount of rain measured on the south coast was an inch and a half, or about half the average for the month; and on the west coast, especially at Liverpool, much damage has been done by floods, occasioned by the excessive amount of rain. Temperature has been low for the season, the daily maxima rarely exceeding 60° in any part of the country, while in the north and west the readings have been much lower; frost has been recorded in the shade in the east of London, and the nights have been very cold generally. For several days a cyclonic area was situated over the United Kingdom, and strong winds were experienced on some coasts; a temporary improvement, however, occurred on Tuesday, although conditions remained very unstable. The *Weekly Weather Report* of the 1st inst. shows that the rainfall was in excess everywhere. In the south-west of England it amounted to 1·2 inch; but there was still a deficiency of 7½ inches since the beginning of the year. The temperature was below its mean value in all districts except the south of England and the Channel Islands, the deficiency being greatest in Scotland and Ireland.

SOME results of seven years' meteorological observations on the Pic du Midi, at a height of about 9500 feet, have been recently published by M. Klengel. The annual mean temperature is $-2.^\circ 2$ C. The annual variation, $14.^\circ 3$, is only one degree less than at Tarbes on the plain, and is about that of the Sonnblick (which is some 800 feet higher than the Pic). April is abnormally cold ($-6{\cdot}^\circ 2$); and this is attributed to the fact that the Pic stands in Van Bebber's fifth depression-path, which is most frequented in that month. While Pipis Peak represents the extreme continental type of high mountain climates, and Etna the oceanic type, in nearly the same latitude, the Sonnblick and the Pic du Midi represent transition types. The maximum zone of precipitation on the Pic lies at about 7700 to 8000 feet; above this there is marked diminution. The results in general show that even at a height of nearly two miles the distribution of land and water on the earth's surface has a considerable influence on climate.

A SHOCK of earthquake, lasting from three to five seconds, was felt at Huelva, between twelve and one o'clock on the morning of September 29. According to a Reuter telegram, three shocks were noticed, the first being weaker than the succeeding disturbances. The direction of the seismic wave was taken from north to south, and the subterranean rumblings were heard very distinctly over a large area. The inhabitants were greatly terrified, but nobody was injured. Many windows were smashed, but beyond this the damage was insignificant.

A CURIOUS instance of globular lightning is referred to in the *Meteorologische Zeitschrift* for September 1892. On August 7, during a thunderstorm at Altenmarkt, near Fürstenfeld, while the priest was administering the sacrament, the church was struck by lightning, followed by a loud explosion. A panic immediately ensued, and the congregation rushed out, notwithstanding the assurances of the priest that there was no danger. There was nothing to show how the lightning entered the church, but it is supposed it was by the conductor leading from the steeple. It is said to have been a large globe, tapering towards the upper part, and after the explosion it left a strong sulphurous smell. The explosion was very loud and shook the building.

The last number of the *Berichte der Deutschen Botanischen Gesellschaft* contains an interim report on the progress of the negotiations concerning the nomenclature of genera, started by a committee of botanists at Berlin to supplement the decisions of the International Botanical Congress held at Paris in 1867. The proposals submitted last April to the consideration of 329 German and Austrian and 377 foreign botanists were the following:—(1) The year 1752 to be taken as the initial date for priority in names of genera, and 1753 for the names of species. (2) Nomina nuda and semi-nuda to be rejected. Drawings and dried specimens without diagnoses to establish no claim to priority of a genus. (3) Similarly sounding generic names to be retained, even if differing only in the ending or by a single letter. (4) The names of the subsequent great or well-known genera to be preserved, even if they ought to be rejected by the strict rules of priority, especially in cases where no change in the names used up to the present can be proved. 360 replies had been received up to the time of the report, amongst them being 157 from Germany, 63 from Austria, and 19 from Great Britain and Ireland. The great majority expressed approval, at least, of the first three proposals. The botanical authorities of the British Museum favour the suggestions, those at Kew are against them.

M. G. Trouvé has built a luminous fountain for Mme. Patti, at her residence at Craig-y-Nos, an account of which appears in No. 11 of the *Comptes rendus*. "The weight of this fountain is about 10,000 kgr., and the basin measures 6 m. in diameter. The illuminating power is represented by four incandescent lamps of 110 volts, each consuming 6 amperes. Thus the total electric energy amounts to 2640 watts; this gives, at three watts per candle, a light intensity of over 800 candles. The lamps are centred at the focus of four parabolic reflectors grouped under the glass chambers whence the water springs. As in the chamber fountains, the metallic ajutages, which would have cast shadows, are eliminated. The water which falls from the upper to the lower basin is utilised to drive a small bucket-wheel, which governs the rotation of two superposed discs, concentric or otherwise, made of coloured glasses, which turn in the same or in the opposite sense, with equal or unequal velocities as required, between the reflectors and the glass. This combination of two discs with opposite rotations renders possible a variation in the play of colours of the liquid sheaves, which succeed each other with the unexpectedness of the kaleidoscope. The motive power can be chosen at pleasure. It may be hydraulic, electric, or by clockwork, of forms and dimensions in keeping with the character of the decoration. These fountains need neither expenses of installation nor costs of maintenance, and their price depends solely upon their artistic perfection and their importance. Hitherto the construction of luminous fountains has only been hindered by the impossibility of sufficiently illuminating the jets. To-day the problem is reversed. Since the light can be projected without sensible loss to great heights, the only difficulty will be to give a sufficiently high pressure to the water."

The Manchester Field Naturalists' and Archæologists' Society closed the out-door session by a visit to Buxton on Saturday, September 24. The field meetings were well attended during the session, and the introduction of an itinerary for each excursion, detailing the natural history features of the district, was of service. The president, Mr. Charles Bailey, F.L.S., usually gave the address upon the botanical specimens observed. At Buxton, the chairman of the directors of the Winter Gardens conducted the party through the grounds, and undertook to convey to his colleagues the desire of the Society that the county ferns and native phanerogams, so far as they will live at the altitude of the gardens, which are a thousand feet above the sea, should be introduced.

At a meeting of the Norfolk and Norwich Naturalists' Society, held in the Norwich Museum on September 27, Mr. Southwell exhibited, by permission of Mr. T. Ground, of Moseley, Birmingham, a Siberian pectoral sandpiper (*Tringa acuminata*), killed at Yarmouth by that gentleman on August 29, which he believed to be the first European example of this bird hitherto recorded.

The administrative report of the Marine Survey of India for the official year 1891-92 has been published. Dr. A. Alcock, Surgeon-Naturalist to the Survey, shows that in his department the year has been by no means unproductive. He expresses his belief, however, that the results would be tenfold greater, both from the scientific and from the economic points of view, if, in the survey of inhabited coasts, the naturalist could follow the ship from camp to camp ashore, visiting it at short, convenient intervals for medical purposes, but otherwise devoting all his time to systematic exploration of the grounds worked by the fishermen—grounds of marvellous richness still quite unexplored and unappreciated.

Among the animals Dr. Alcock has specially observed is the red ocypode crab, which swarms on all the sandy shores of India. The bigger of its two chelæ, or nippers, bears across the "palm" a long finely-toothed ridge, and on one of the basal joints of the "arm," against which the "palm" can be tightly closed, there is a second similar ridge. When the "palm" is so folded against the base of the "arm," the first ridge can be worked across the second, like a bow across a fiddle, only in this case the bow is several times larger than the fiddle. The remarkable resemblance of the whole arrangement to the stridulating apparatus of many insects led Prof. Wood Mason some time ago to infer a similarity of function; and he asked Dr. Alcock to observe the crabs, and to listen for the sounds which he supposed them to be capable of making. Dr. Alcock is now able to give facts which establish the truth of Prof. Wood Mason's idea. The sounds can be heard, and their effects seen, if one crab, which may be called the intruder, is forced into the burrow of another, which may be called the rightful owner. The intruder shows the strongest reluctance to enter, and will take all the risks of open flight rather than do so, and when forced in he keeps as near the mouth of the burrow as possible. When the rightful owner discovers the intruder he utters a few broken tones of remonstrance, on hearing which the intruder, if permitted, will at once leave the burrow. If the intruder be prevented from making his escape, the low and broken tones of the rightful owner gradually rise in loudness and shrillness and frequency until they become a continuous low-pitched whirr, or high-pitched growl, the burrow acting as a resonator. Dr. Alcock concludes that the use of the stridulating organ appears to be that a crab, when it has entered its burrow, may be able, by the utterance of warning notes, to prevent other crabs from crowding in on top of it.

Dr. Fritz Noetling has been investigating the amber and jade mines of Upper Burma, and sets forth the results of his inquiry in the new number of the Records of the Geological Survey of India. The strata in which the amber is found belong to the tertiary formation, probably to the lower miocene. Dr. Noetling does not think that Burmese amber would be received with much favour in Western markets—first, because it does not include the milky-white, clouded variety which has for a long time been so much appreciated in Europe; second, because of its fluorescence. This is the bluish tinge which appears when the amber is looked at under a certain angle—a tinge which is sometimes so strong that fine yellow pieces seem to be of an ugly greenish colour.

Dr. Noetling has formed a higher idea of the value of the jade mines of Burma. There are two different groups of jade mines—pit and quarry mines. The former are situated along the bank of the Uru river, beginning at about Sankha village, and extending for a distance of about forty miles farther down. The quarry mines near Tammaw village are situated eight miles west of the Sankha village, on the top of a plateau rising to about 1,600 feet above the level of the Uru river. The Tammaw mines afford the best opportunity for the study of the geological conditions under which the jade is found. It there forms a vein of considerable thickness in an igneous rock of blackish-green colour. The jade is a purely white crypto-crystalline mineral, much resembling the finest marble, containing here and there green specks of various sizes, which form the jade proper. The jade vein is separated from the black rock by a band of a soft and highly decomposed argillaceous mineral. The strike of the vein is approximately north to south, and the dip at about an angle of 20°, varying considerably towards east. There are at least 500 men engaged every season in working the quarry mines at Tammaw. The mining operations are carried on in the rudest fashion. No blasting powder being available, the rock is heated by large fires, and, having cooled down, is broken in pieces by means of enormous iron hammers. The operations in the pit mines are less difficult. The miner simply digs a pit and selects boulders of jade from the stuff dug out. Good pieces of jade are sometimes found in the laterite, which forms beds of varying thickness along the Uru. These pieces have superficially undergone a certain discolouring in such a way that the original green or white is changed under the influence of the hydrated oxide of iron into a dark red colour. Specimens of this kind are generally known as "red jade." Dr. Noetling says that the jade mines form a most valuable property. He has no doubt that besides the Tammaw jade vein others will be discovered. We know now that jade is intimately associated with a dark igneous rock (trap), and Burma abounds in rocks of this kind.

Mr. Otis T. Mason contributes to the latest report of the U. S. National Museum (for 1890) an interesting study of the ulu, or woman's knife, of the Eskimo. The ulu is found throughout the Eskimo region, from Labrador to Kadiak, and consists of a blade and a handle or grip with or without some form of lashing. The blade is either a thin piece of slate ground to an edge, a bit of cherty or flinty rock chipped to an edge, a scrap of steel or iron from wrecks of whaling vessels, or good blades made and sold to the Eskimo by traders who visit their country. The handle varies greatly in material, form, and finish. In form alone the specimens from each typical area are unique. Some of the ulus in the U. S. National Museum are as coarse as savagery could make them; others are very beautiful. The same locality furnishes both and intervening kinds, but some areas supply only coarse work. The problem has to some extent been complicated by white influence. The ulu has survived in civilized countries under two well-known forms—the saddler's knife and the kitchen knife. The saddler thus perpetuates, for cutting leather, an implement designed to be used with skins from which the hair has not been removed. The kitchen chopper is the woman's knife deprived of nearly all its ancient and primitive offices, consigned to a single one, which it scarcely had at the beginning. The saddler's knife may be seen in the hands of leather-cutters represented on Egyptian monuments. An excellent series of illustrations, grouped in accordance with the regions from which the specimens come, adds greatly to the interest and value of Mr. Mason's paper.

It is a common experience in daily life that milk has in itself little or no tendency to putrefaction, and that it may even to some extent preserve certain substances that are readily decomposed, such as meat. This property has lately been investigated by Herr Winternitz, in Strasburg. Of the three chief constituents of milk, viz., casein, fat, and milk sugar, the first proved as liable to putrefaction as the meat or pancreas extract experimented with; the fat, too, had no preservative influence. Milk-sugar, on the other hand, in accordance with what is known regarding the power of carbohydrates to retard putrefaction, acted as strongly as cane-sugar. Nothing definite was ascertained as to the nature of this action. It was proved, however, to take place in the alimentary canal as well as outside of the system.

Rats at Milnthorpe, Westmoreland, seem to have found a fresh outlet for their predatory impulses. Mr. G. Reade, in a letter quoted in the new number of the *Zoologist*, says that the ripe gooseberries in his garden there were disappearing very rapidly this year, and he supposed that the mischief was being done by blackbirds. However, his attention was called to a large rat taking the berries off with his mouth and dropping them to other rats below. Presently another climbed the tree and helped to gather the berries. In a little time both came down, each with a berry in its mouth, having a curious appearance. Mr. Reade saw the performance several times repeated. Then he placed a wire cage under the tree, and in three days caught nine of the intruders.

The electric light seems to have an extraordinary attraction for lepidoptera. On August 19, as he records in the new number of the *Entomologist*, Mr. D. S. Stewart had an opportunity of noting this fact. At the Eddystone lighthouse exhibited in the Botanic Gardens at Old Trafford (the same lighthouse as was shown at the Naval Exhibition), he saw great numbers of moths. Before ascending, he says, one could see them from below, flashing in and out of the rays in hundreds; and when the top was reached, the place was found to be full of them—"some, apparently dazzled by the light, frantically flying in all directions, buzzing and banging in your face, up your sleeves, down your neck, everywhere. In every sheltered niche and cranny four or five were to be seen together, and especially was this so on the staircase, which was strewn with their partially cremated remains, the result of their all too successful attempts at self-immolation."

A valuable paper on the breeding-habits, eggs, and young of certain snakes, by O. P. Hay, is printed in the latest volume (xv.) of the Proceedings of the U.S. National Museum, and has also been issued separately. Mr. Hay notes that, although serpents have made a deep impression on the human mind, very little accurate information has been accumulated concerning some of their habits. His paper embodies the results of a good deal of careful personal observation.

The Nova Scotian Institute of Natural Science has changed its name to the Nova Scotian Institute of Science, and has secured an Act of Incorporation. It has now begun the second series of its "Proceedings and Transactions," the first part of vol. i. having just been issued. Among the papers in this part are "Notes on the surface geology of South-Western Nova Scotia," by Prof. L. W. Bailey; "Steam boiler tests as a means of determining the calorific value of fuels," by D. W. Robb; "Analyses of Nova Scotia coals and other minerals," by E. Gilpin, jun.; "The Magdalene Islands," by the Rev. Dr. G. Paterson; "Notes for a Flora of Nova Scotia," Part 1 by Prof. G. Lawson.

Messrs. Williams and Norgate are about to publish a work entitled the "Cry of the Children," by "Free Lance." It deals with education in a wide sense, but more especially it advocates the necessity of a scientific training.

PART I. of a new work on practical physics, by Prof. W. F. Barrett, of the Royal College of Science for Ireland, will shortly be published by Messrs. Percival and Co. It will treat of physical processes and measurements, and the properties of matter.

THE University Correspondence College has issued its calendar for 1892-93. The Principal, in his report, shows that the college has been in many ways remarkably successful.

THE calendar of the Imperial University of Japan for 1891-92 affords ample evidence that the authorities of this important institution are doing everything in their power to secure that it shall meet the needs of the present age. We may note that in the college of science the following seven courses, each of which extends over three years, have been established: Mathematics, astronomy, physics, chemistry, zoology, botany, and geology.

IN the last sentence of the fourth paragraph of Lord Kelvin's article on "Generalization of Mercator's Projection Performed by aid of Electrical Instruments" (NATURE, September 22, p. 491), for "three" read "two." For corrections in paragraph 3, and in the last paragraph but one, see article "To Draw a Mercator Chart, &c.," in the present issue.

AN interesting new compound, the silver salt of the little known imide of sulphuric acid, SO_2NAg, has been obtained by Dr. Wilhelm Traube, in the laboratory of the University of Berlin, and an account of its properties, together with a considerable amount of fresh information concerning both the amide and imide of sulphuric acid, are contributed by him to the current number of the *Berichte*. Regnault long ago obtained a solid substance, which he regarded as a mixture of the neutral amide of sulphuric acid $SO_2(NH_2)_2$ with ammonium chloride, by leading ammonia gas into a solution of sulphuryl chloride SO_2Cl_2 in ethylene chloride.

$$SO_2Cl_2 + 4NH_3 = SO_2(NH_2)_2 + 2NH_4Cl.$$

The separation of the two substances, however, was but imperfectly effected, so that our knowledge of the amide itself is very vague. Dr. Traube now shows that the amide may be isolated without difficulty by the following process. The sulphuryl chloride is dissolved in fifteen times its volume of chloroform, which exerts no chemical action upon it, and dry ammonia gas is led through the liquid until the latter becomes saturated. The products of the reaction separate during the passage of the gas in the form of a white solid. The whole product is then agitated with water until the precipitate dissolves, the aqueous solution is separated from the chloroform and afterwards boiled in contact with oxide of lead or silver until all chlorine is removed from it. Upon filtering and evaporating the resulting liquid a syrup is eventually obtained, which only crystallizes with difficulty and would appear to consist of neutral sulphamide $So_2(NH_2)_2$. It is an extremely deliquescent substance whose solution in water and dilute acids is not precipitated by salts of barium or by platinic chloride. Only after prolonged boiling with hydrochloric acid does decomposition occur with the gradual deposition of barium sulphate. The effect of boiling in the presence of acids would appear to be its conversion into ammonium sulphate. Sulphamide possesses the power of combining with the oxides of mercury, lead, and silver, to form white solid substances. Thus if mercuric nitrate, lead acetate, or ammoniacal silver nitrate are added to the aqueous solution of the amide these white solid compounds are precipitated. The mercury compound is insoluble in dilute nitric acid, while the lead and silver compounds are readily soluble, forming solutions which are perfectly indifferent to barium salts. It was from the compound containing silver that the interesting silver imide was obtained. Upon heating the silver compound to the temperature of 170°–180° until ammonia ceases to be evolved, and extracting the residue with hot water feebly acidified with nitric acid, the new compound SO_2NAg separates upon cooling in long acicular crystals. Analyses have proved its composition to be that stated, and from its reactions it must be regarded as being the silver salt of sulphimide SO_2NH. The crystals are only soluble with difficulty in cold water, but more freely in hot water and readily in dilute nitric acid. The solution is not precipitated by barium nitrate. Even after removal of the silver by means of hydrochloric acid barium salts yield no precipitate; indeed, it requires long boiling with concentrated acid to effect any precipitation. It would appear that the solution left after removal of the silver contains sulphimide itself, and Dr. Traube is continuing his experiments with a view to the isolation of the latter compound.

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseoviridis* ♀) from South Africa, presented by Mr. W. Howard; a —— Lark (*Alauda cœlivox*) from China, presented by Mr. Gervase F. Mathew, R.N., F.Z.S.; two Common Kestrels (*Tinnunculus alaudarius*), British, presented by Mr. L. Bergasse: a Herring Gull (*Larus argentatus*), British, presented by Mr. H. H. Johnson; a Tuatera Lizard (*Sphenodon punctatus*), from New Zealand, presented by Capt. G. Eriksen; four Smooth Snakes (*Coronella lævis*) British, presented by Mr. E. Penton, F.Z.S.; six American Green Frogs (*Rana halecina*), four Noisy Frogs (*Rana clamata*), from Canada, purchased; one Concave-casqued Hornbill (*Dichoceros bicornis*), from India, received in exchange; three Wild Swine (*Sus scrofa*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (AUGUST 27, 1892).—*Astronomische Nachrichten*, No. 3119, contains the elements and ephemeris of Brooks's comet calculated by F. Ristenpert, assuming an elliptical orbit and the unit of brightness on August 31·5 as the unit of Br.:—

Elements.

T = 1892 Dec. 28·2870 M.T. Berlin.

$$\begin{aligned} \omega &= 252^\circ\ 4'\ 23''{\cdot}0 \\ \Omega &= 264\ \ 34\ \ 45{\cdot}3 \\ i &= 24\ \ 43\ \ 17{\cdot}1 \\ \log. q &= 9{\cdot}994136 \end{aligned}$$

Ephemeris for 12h. Berlin M.T.

1892.	R.A. app. h. m. s.	Decl. app. ° ′	Log. r.	Log. Δ.	Br.
Oct 6	7 45 22	+24 47·5			
7	48 30	24 26·9	0·2204	0·1763	3·71
8	51 40	24 5·6			
9	54 51	23 43·6			
10	7 58 4	23 20.9			
11	8 1 18	22 57·4	0·2077	0·1542	4·35
12	8 4 34	22 33·3			

This comet on the 11th inst. will be found situated in the constellation of Cancer. It will lie very nearly on a line joining the stars κ Gemini and δ Cancri, being about a third of the distance nearer the former than the latter.

COMET 1892 II. (MARCH 18).—The following ephemeris for Denning's comet we take from the *Astronomische Nachrichten*, No. 3118:—

12 *Berlin Mean Time.*

1892.	R.A. app. h. m. s.	Decl. app. ° ′	Log r.	Log Δ.	Br.
Oct. 6	6 23 9	+11 54·0			
8	22 0	11 6·3	0·4250	0·3604	0·64
10	20 43	10 17·9			
12	19 19	9 28·8	0·4300	0·3539	0·65
14	17 48	8 39·1			
16	16 9	7 48·9	0·4349	0·3478	0·65
18	14 23	6 58·4			
20	6 12 29	6 7·6	0·4398	0·3423	0·65

Nova Aurigæ.—In some further notes that we have referring to the brightness and the spectrum of the Nova, we find that most observers estimate the star's magnitude to lie between 10 and 10.5. Herr Belopolsky, who has examined the star spectroscopically, has been able to see one or two lines; a later estimation of the brightest gave a wave-length of 501, while the second line proved too variable in brightness to allow of a sufficiently correct measurement.

To *Astronomische Nachrichten*, No. 3118, Mr. H. Seelinger contributes a very important article, in which he suggests an hypothesis which may be said to approach that put forward by Mr. Lockyer some time ago. He assumes (and a very fair assumption too) that the cosmos contains innumerable more or less elongated forms of very thin and small particles, and that the Nova was produced by a body rushing into one of these, so to speak, clouds. On entering this cosmical cloud, at once there would be a condition for producing heat, and therefore light, and we have only to imagine the cloud to be of varying thicknesses to account for the peculiar fluctuations which attended the light of the Nova. That such a case should take place seems in itself more probable than that of two bodies passing very near one another, and we already know that such streams as suggested do exist. Our November shower, for instance, is such a swarm, only on a scale very much smaller than that inferred above.

GEOGRAPHICAL NOTES.

Until recently the Samoan calendar corresponded with the Australian, but on July 4 last a change was made by order of King Malietoa. Tuesday, July 5, was reckoned a second time as Monday, July 4, thereby coming into harmony with the American and European reckoning. Samoa, lying to the east of 180°, had retained the old system of time, superseded by the general acceptance of that meridian as the line at which the date is rectified by vessels at sea.

Captain Lugard reached London from Uganda on Sunday night. It is gratifying to know that his three years' residence in equatorial Africa, and the severe strain of recent events, have not told adversely on his health. He will probably communicate the important geographical results obtained by him to a special meeting of the Royal Geographical Society in November.

The arrangements for the next session of the Royal Geographical Society present several new features. In addition to the ordinary meetings it is proposed to give a special series of Christmas lectures to young people; to be followed by a course of ten weekly educational lectures, specially adapted for teachers, by Mr. H. J. Mackinder. The ordinary meetings as provisionally arranged begin on November 14 by a paper on his proposed North Polar expedition by Dr. Nansen. Mr. Joseph Thomson will follow with an account of his expedition to Lake Bangweolo. Captain Bower will describe his journey across Tibet, and Captain Lugard will recount his discoveries in equatorial Africa. Prof. Milne and Mr. Savage Landor have promised papers on Yesso, Major Rundell on the Siyin Chins, Mr. H. O. Forbes on the Chatham Islands, and Captain Gallwey on Benin. It is hoped that Mr. Conway will return to describe his adventures in the Karakoram mountains. Apart from the records of travel to which the attention af the Society in its ordinary meetings has usually been mainly devoted, there will be papers dealing with the more general and scientific aspects of Geography. The Prince of Monaco will probably describe his experiments on the Atlantic currents, Sir Archibald Geikie will lecture on types of scenery, Prof. Bonney on the work of glaciers, Mr. J. Y. Buchanan on the windings of rivers, and Dr. Schlichter on his new photographic method of determining longitude.

The last number of *Petermann's Mitteilungen* contains an important paper by Dr. Alois Bludau giving the co-ordinates for Lambert's equivalent area azimuthal projection of the map of Africa. An outline of the continent on this projection, the central point of which is on the equator in 20° E. long., shows the remarkable suitability of the map for representing Africa, the distortion being inappreciable.

MAGNETIC INDUCTION.[1]

The lecturer remarked that it was no less than forty-five years since the magnetic properties of materials had formed the subject of an evening discourse before the British Association. At the Oxford meeting in 1847 the lecturer was Michael Faraday, who had only a little while before made his great discovery of diamagnetism and been led to the splendid generalization that all substances are in one way or other, and in greater or less degree, susceptible of magnetic influence. And it was an interesting coincidence that in the same year, partly indeed at that same Oxford meeting of the Association, the foundation of the modern mathematical treatment of magnetism had been laid by that infant phenomenon, whom in the vigour of his maturity we were now learning to call Lord Kelvin. Discarding the arbitrary hypotheses of earlier theoretical writers, Lord Kelvin, then a stripling at Cambridge, had proceeded to give mathematical expression to the observations and intuitions of Faraday. In recent years the science of magnetism had advanced fast, keeping pace with the advance of its industrial applications. In common with other branches of electricity it had discovered the advantage of being useful. The debt which practice owed to science had been repaid with interest. In other departments of science it might be true that there were devotees whose chief pride in their work lay in their reflection that it could never be of any use to anybody: this temper of mind was not possible to an electrician. The language of electricians had passed with bewildering rapidity into Acts of Parliament and provisional orders of the Board of Trade, and the demands of industry had stimulated discovery and fostered exactness in measurement. It was the beneficent reaction of practice on science that had enabled the great work of the Electrical Standards Committee of the British Association to be brought to a successful issue. As a fruit of that work electricians were in high hope that this Edinburgh meeting would result in an international agreement with regard to the electrical units, so that whatever the Great Powers might find to differ about they would at least be of one mind as to the magnitude of the volt, the ampere, and the ohm. In the co-operation of Prof. von Helmholtz on the part of Germany, and of M. Mascart on the part of France, with Lords Kelvin and Rayleigh and their English colleagues, there were surely the elements of a Triple Alliance which should secure to the electrical world peace, not only with honour, but with precision.

The lecture of Faraday in 1847 had dealt with the condition induced by magnetic force in matter which was not ordinarily magnetic. Substances were broadly divisible into two classes, those which were strongly susceptible to magnetic influence and those that were only very feebly susceptible. The latter was by far the most numerous class, and it was with it that Faraday dealt in his lecture. The strongly magnetic substances were iron and its various derivatives, which passed by the general name of steel, also nickel and cobalt. A recent discovery by Prof. Dewar seemed to require that oxygen, in the liquid state, should be added to this list. The lecturer proposed to confine his attention to the phenomena of magnetization which were exhibited by the strongly magnetic metals. Let any one of these metals be submitted to the action of a magnetizing force such as would be produced if an electric current were passed through a coil of insulated wire surrounding the metal. As the current was gradually increased, the magnetization passed through three stages. It began very gradually; at first, while the current was still weak, there was but little magnetism developed. Then a stage came on in which the magnetic state was acquired with great rapidity; a small increase in the current now caused an enormous gain of magnetism. Finally, the process passed into a third stage, when the magnetism was again acquired slowly, and however much the magnetizing current was increased it was found to be impossible to force the magnetism to exceed a certain limiting value. This was the phenomenon of magnetic saturation. Recent researches had given definiteness to the rather vague idea which used to be expressed by this phrase, and it was now known not only that a limit existed, but what its values were in the several magnetic metals. The lecturer illustrated the three stages in the magnetizing process by means of the lantern, exhibiting curves which showed the connection between mag-

[1] Abstract of an evening lecture delivered before the British Association, at Edinburgh, August 8, 1892, by J. A. Ewing, M.A., F.R.S., Professor of Mechanism and Applied Mechanics, Cambridge University.

netism and magnetizing force, and pointed out that in special cases the three stages became extraordinarily distinct. Curves of the same kind were used to show what happened after a magnetizing force had been applied, if it were withdrawn or varied in any way. The magnetism in all cases tended to lag behind when the magnetizing force was varied, and hence these curves in any cyclic process became loops enclosing a certain area. It had been proved that this area served to measure the energy expended in carrying the substance through a cyclic magnetizing process, the reason why energy had to be spent being the tendency which the magnetism always had to lag behind the force that was operating to change it. To this tendency he had given the name "hysteresis," a term which was already of formidable significance in the ears of practical electricians. For the existence of hysteresis was the chief reason why the transformers which were used in alternate current systems of electrical distribution absorbed wastefully a considerable amount of power. The iron core of a transformer was being carried through a cycle of magnetization from a positive to a negative value and

Weber postulated an arbitrary directing force, which tended to hold them in their original direction. The lecturer proceeded to show by means of experiments conducted on the projecting table of the lantern, and shown on a large scale on the screen, that no arbitrary directing force was necessary. The mutual actions of the molecular magnets on one another supplied all the control that was required. It accounted completely for the three stages of the magnetizing process and for all the phenomena of hysteresis. It accounted also for the effects which were found to be produced by mechanical vibration and mechanical strain. Experiments were made exhibiting the breaking up of molecular groups, bound together by their mutual forces, under the influence of a gradually increased external directing force. In these experiments models were used, consisting of a number of small magnets, pivoted like compass needles on fixed centres, and arranged on the horizontal table of a large projecting lantern. A pair of coils placed one on either side of the group supplied deflecting force, and as the current in these was gradually increased the three stages of the magnetizing

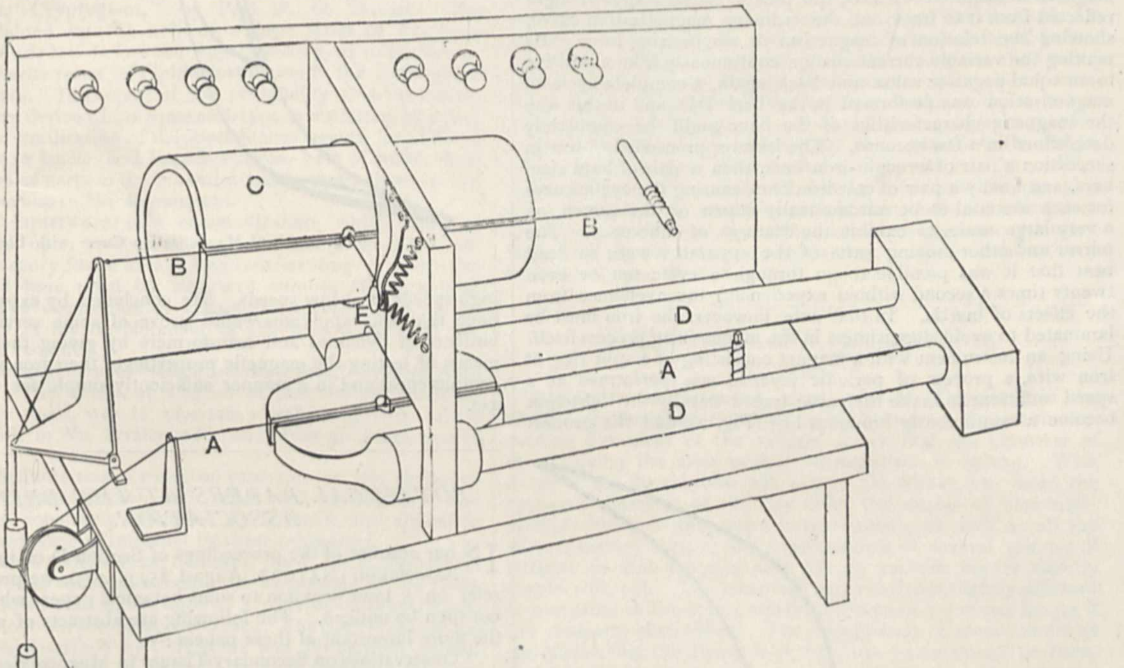


FIG. 1.—Prof. Ewing's Mognetic Curve Tracer. General view of apparatus.

back again some 80 or 100 or 120 times a second, and every one of these periodic reversals of magnetism implied a waste of energy, which went on even when no useful current was being drawn off. It was a question of considerable practical interest, whether the amount of work wasted on the iron of a transformer was the same per cycle at high speeds of reversal such as were usual in practice, as it was in the slow speed laboratory experiments, by the help of which these cyclic curves had been drawn.

The lecturer proceeded to give some account of molecular theories which had been framed to account for the characteristics of the magnetizing process. It was suggested, originally by Weber, that the molecules of iron are always little magnets, and that when the iron, as a whole, is not magnetized, it is because as many of the molecular magnets are facing one way as another. According to this view the process of magnetization consists in turning the molecular magnets round, so that they face, more or less, one way. When a very strong magnetising force is applied, the molecules are forced all to face one way; the piece is then saturated. To explain why they did not at once turn round completely when any magnetizing force was applied,

process and the phenomena of hysteresis exhibited themselves in the manner in which rearrangement of the elementary magnets composing the group took place. In some of the models the magnets turned under water, so that their vibrations were rapidly damped out. Slides were also shown which gave some of the results of observations recently made in the lecturer's laboratory by Miss Klaassen, of Newnham College, which demonstrated an extraordinarily close agreement between the phenomena noticed in the magnetization of actual iron and those presented by a model consisting of groups of little pivoted magnets. Even the less conspicuous features of the actual process were reproduced in the model with a fidelity which went far to confirm this molecular theory of magnetism. It was shown, for instance, that the model reproduces a phenomenon familiar in real iron, namely, the tendency which magnetic changes exhibit to be imperfectly cyclic, under cyclic changes of magnetic force, until these are repeated several times, and also that in the model, just as in real iron, this tendency disappears if a process of demagnetizing by reversals of gradually diminishing magnetic force has been previously gone through.

The lecturer proceeded to show in action a novel apparatus he had devised to exhibit the magnetizing process in actual iron, and to test the magnetic qualities of metals. This magnetic curve tracer (Fig. 1) consists of two wires—AA and BB—tightly stretched in two narrow gaps in the magnets DD and C respectively. The magnet C consists of a piece of slotted iron tube, which is kept constantly magnetized. Consequently, when a variable current passes along the wire BB that wire sags out or in, giving azimuthal movement to a mirror E. The variable current which passes through the wire B serves to magnetize the electromagnet DD, which consists of two bars of the iron to be tested, sunk into fixed pole pieces and united at the back end by a short yoke-piece of soft iron. When the magnetism of DD varies it causes the wire AA, which carries a *constant* current, to sag up and down, and this gives movement in altitude to the mirror E. The mirror is pivoted on a single needle point, and has freedom to respond to the motion of both the stretched wires AA and BB. Since its azimuth movement is proportional to the magnetizing current, and its altitude movement is proportional to the magnetism acquired by DD, the mirror causes a spot of light reflected from it to trace out the ordinary magnetization curve, showing the relation of magnetism to magnetizing force. By making the variable current change continuously from a positive to an equal negative value and back again, a complete cycle of magnetization was performed in the bars DD, and in this way the magnetic characteristics of the bars could be completely determined in a few seconds. The lecturer proceeded to test in succession a pair of wrought-iron bars, then a pair of hard steel bars, and finally a pair of cast-iron bars, causing the cyclic curve for each material to be automatically drawn on the screen, on a very large scale, to exhibit the features of difference. The mirror and other moving parts of the apparatus were so dead beat that it was possible to go through a cycle ten or even twenty times a second without experiencing inconvenience from the effects of inertia. In that case, however, the iron must be laminated to avoid sluggishness in the magnetizing process itself. Using an instrument with a magnet consisting of a split ring of iron wire, a process of periodic reversal was performed at a speed sufficient to make the curve traced out by the light-spot become a continuously luminous line (Fig. 2), and the process

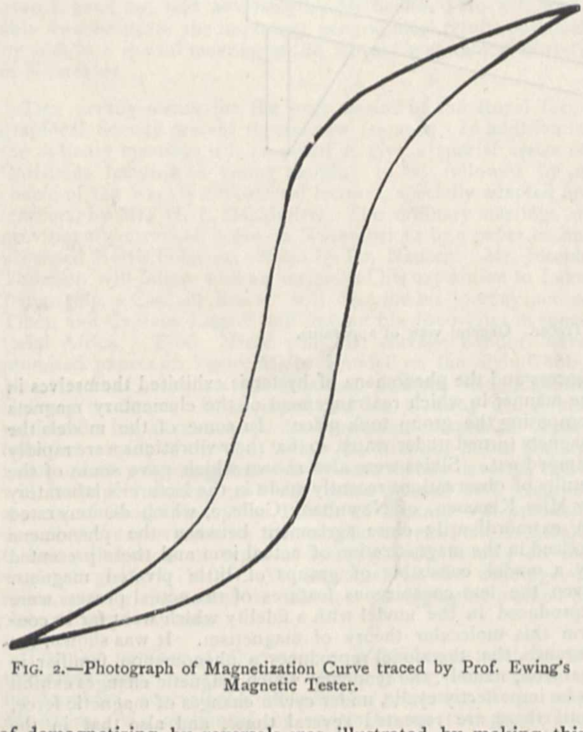


FIG. 2.—Photograph of Magnetization Curve traced by Prof. Ewing's Magnetic Tester.

of demagnetizing by reversals was illustrated by making this curve gradually contract itself to zero by slowly reducing the strength of the current while the rapid periodic reversals were continued. The effect was also shown of superposing one periodic alternation upon another, by which loops resembling those of Fig. 3 were drawn. The lecturer pointed out that these experiments went some way towards answering the question whether the magnetizing process went on in the same way, and involved the same dissipation of energy through hysteresis, at

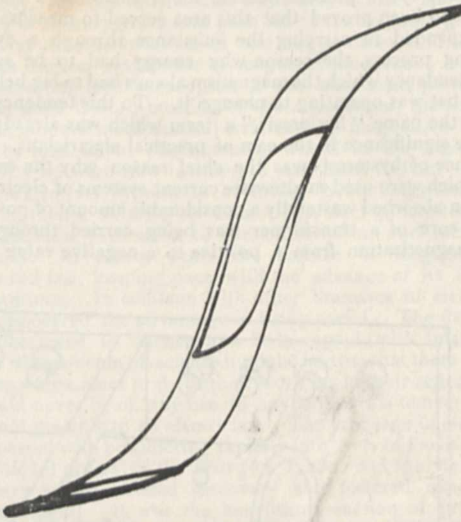


FIG. 3.—Photograph of Magnetization Curve with Loops.

high speeds as at low speeds. He concluded by expressing the hope that this apparatus would prove of some service to the builders of dynamos and transformers by giving them a novel means of testing the magnetic properties of their iron with great completeness and in a manner sufficiently simple for workshop use.

BOTANICAL PAPERS AT THE BRITISH ASSOCIATION.

IN our account of the proceedings of Section D of the British Association (NATURE, August 25, p. 403), we promised to refer on a later occasion to some botanical papers which could not then be noticed. The following are abstracts of several of the more important of these papers :—

"Observations on Secondary Tissues in Monocotyledons," by Dr. Scott and Mr. Brebner. (1) The secondary tracheides in Dracæna and Yucca develop simply by the enormous growth in length of single cells, the nuclei remaining undivided, and not by cell fusion, as many authors suppose. (2) The cambium in the roots of many species of Dracæna does not appear in the pericycle, but in the cortex outside the endodermis. The secondary growth starts from the insertion of a rootlet, the cambium being pericyclic near, and cortical at a greater distance from, the rootlet. (3) Description of secondary thickening in Iridaceæ.

"On the Simplest Form of Moss," by Professor Goebel. The author stated that previous researches had led him to the conclusion that mosses and ferns did not stand in direct genetic relationship with each other, but that they are descended from simple alga-like forms ; in fact the mosses pass through a developmental stage so alga-like in appearance that it was formerly described as an algal genus *Protonema.* If the sexual organs of the moss arose not on the stem but on the protonema, we should have the sexual generation agreeing perfectly with the filamentous algæ. The leaves of the moss would then arise originally as protective organs for the antheridia and archegonia. This, up to the present, hypothetical form, actually occurs in Buxbaumia. In this moss the antheridia occur at the end of a protonema-branch, surrounded by a mussel-shaped envelope. The female plant is more highly organised, but is still much simpler than in other mosses. These and other observations lead Prof. Goebel to the conclusion that Buxbaumia is a very ancient form which stands in the closest relation to the lower algæ.

"On the cause of Physiological Action at a Distance," by Prof. L. Errera (Brussels). The author referred to Elfving's observation, that sporangium-bearing filaments of *Phycomyces nitens* are attracted by iron, zinc, aluminium, and various organic substances, such attractions not being due to gravitation, light, moisture or contact, but to physiological action at a distance, as Elfving terms it.

The author has made numerous experiments which tend to show that the attraction is really hydrotropic, the filaments being attracted by hygroscopic and repelled by non-hygroscopic substances, for example:—

Any modification of iron which lessens its capacity of rusting at the same time diminishes its attraction on Phycomyces: thus, polished steel scarcely attracts, and nickled steel does not do so at all.

China clay, which is very hygroscopic, attracts energetically, while china exhibits no attraction. These experiments succeed also in a saturated atmosphere, which shows that hydrotropism is not due, as generally supposed, to differences in the hygrometric state of the air.

"Notes on the Morphology of the spore-bearing members in the Vascular Cryptogams," by Prof. F. O. Bower. The author explained by the help of a large series of diagrams his views already laid before the Royal Society, as to the homology of the fertile frond of Ophioglossum with the sporangium of Lycopodium. In support of the probability that the former may have been derived from some such type as the latter, by a process of partial sterilization of the sporogenous tissues, he adduced facts relating to Isoëtes and Lepidodendron, both of which show a sterilization of parts of the potential sporogenous tissue in the form of trabeculæ in the sporangium.

Mr. C. T. Druery sent in a communication, which was read and remarked upon by Prof. Bower. It related to a new example of apospory found in a young fern seedling, of which the second frond bore upon its margin a number of prothalloid growths. The occurrence of aposporous development at so early a stage in the development of the sporophyte had not hitherto been recorded.

"On the arrangement of buds in Lemna Minor," by Miss Nina F. Layard. The object of a series of observations made on budding duckweeds, was to ascertain whether any fixed rule is followed, both in the arrangement and order of production of the buds.

Prof. F. Schmitz read a paper on tubercles on the thallus of *Cystoclonium purpurascens* and other red seaweeds. The tubercles are constantly inhabited by bacteria, and appear to arise in consequence of infection by these organisms.

"Calamostachys Binneyana, Schimp.," by T. Hick. The object of the paper is to revise and extend our knowledge of the structure of this fossil fruit in the light of a number of preparations which have not been previously described. The central part of the axis, formerly described by Carruthers and Williamson as vascular, the author finds to be cellular, thus removing the chief ground for Williamson's reference of the spike to the Lycopodiaceæ. Round the cellular pith there are (usually) three primary vascular bundles, which are reduced to the condition of those met with in *Equisetum*, and the young shoots of *Calamites*, *i.e.* to as many carinal canals with annular and spiral vessels adhering to the margin.

As to the affinities, the conclusion arrived at is that the fruit is that of some form of *Calamites*—as Carruthers maintained long ago—and perhaps that of the type known as *Arthropitys*.

"Myeloxylon from the Millstone Grit and Coal-Measures," by Mr. A. C. Seward. Specimens of Myeloxylon (Brong.), [Stenzelia (Göpp.), Myelopteris (Ren.)] were described from a limestone of Millstone Grit age in North Lancashire, their minute structure being fairly well preserved, and showing collateral bundles, gum canals (?), and the hypodermal tissues characteristic of the genus. A much more perfect example from the Binney collection was referred to, of coal-measure age, in which not only the xylem but also the phloem elements had been mineralised in an unusual state of perfection.

It was pointed out that in the Binney specimen the position of the Protoxylem on the Phloem side of the bundles was clearly shown both in transverse and longitudinal sections. The affinities of Myeloxylon with Cycads and Ferns were briefly discussed, and the conclusion arrived at that this extinct genus, although differing in certain particulars both from Cycads and Ferns, should be placed much nearer the former than the latter.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for September contains the conclusion of "Objections to Faye's Theory of Cyclones," by W. C. Moore. Only a few of the more essential characteristics of cyclonic storms have been considered, but from these the author concludes that it is evident that the generally accepted theory of convectional motion gives a more satisfactory explanation of the various phenomena than the theory advanced by M. Faye.—"Changes of Plane of the Mississippi River," by Prof. T. Russell. The author analyses a report by Colonel C. R. Suter, of the Mississippi River Commission relating to the improvement of the river and methods of preventing overflow.—"Thunderstorms in New England during the Year 1887," by R. de C. Ward. The difficulty of predicting thunderstorms is shown by the fact that in New England in 1887 the majority of storms occurred in the south-eastern quadrant of cyclones, while in the previous year the majority occurred in the southern or south-western quadrant. Only 40 per cent. of the summer thunderstorms of 1887 occurred in the southern part of cyclonic storms, while in the previous year the number was 70 per cent.—"Weather Forecasting at the Signal Office, June 30, 1891," by Prof. H. A. Hazen. At this date the weather service was transferred to the Agricultural Department, and the author has given the results of his experience by laying down certain fundamental rules which would be of service to a beginner in the work, as it has sometimes been suggested that it would be almost impossible for a forecaster to impart his knowledge to another.—"The Effect of Topography upon Thunderstorms," by R. S. Tarr. The author's observations have led him to believe that topography has a decided effect upon the path of thunderstorms when they are beginning. When, however, the storm has assumed more than local proportions, topography has in all probability very little effect upon its motion.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, Sept. 26.—M. Duchartre in the chair.—On the white rainbow, by M. Mascart. A new mathematical treatment of the subject shows that the diameter of drops giving the most perfect achromatism is $29\cdot17\mu$. With drops of 30μ the rainbow will appear the whiter, the more the apparent diameter of the sun hides the excess of blue intermediate between the achromatised points, as well as all the supernumerary arcs, by the superposition of several systems of fringes, so that there is only left an exterior border slightly tinged with red. The same will apply to drops slightly different in one sense or the other, but the achromatism persists longer if the diameter diminishes. The observation of clouds and fogs has shown that the diameter of the drops varies from 6 to 100μ, the last beginning to fall as rain. Thus the circumstances favouring the production of white rainbows are of very frequent occurrence.—Places of origin or emergence of the great cholera epidemics, and particularly of the pandemic of 1846–49, by M. J. D. Tholozan. From Dr. Arnott's communications to the Physico-medical Society of Bombay, from the documents of the Medical Committee of Bengal, and from the testimony of Ferrier, who was travelling in Afghanistan at the time, it is evident that the cholera epidemic which invaded Europe and America in 1847, 1848, and 1849 originated in Bokhara, whence it spread to Afghanistan and India, as well as westward. Bokhara, Samarkand, Balkh, and Kunduz were attacked at the end of the summer of 1844, Herat and Kabul in October, Jellalabad at the beginning, and Peshawur at the end of November. In the following summer the epidemic proceeded steadily eastwards into the "endemic area," reaching Jhelum and Lahore in May, 1845, Meerut in August, and Delhi and Agra in October, at the same time passing down the Indus to Kurrachee, and westwards to Meshhed, whence it proceeded in 1846 to Asterabad, Teheran, Recht, and Baku. A similar example of an eastward progress of cholera occurred in 1865, when the great epidemic of Mecca, after having invaded Mesopotamia and Transcaucasia, spread to Teheran, and took the easterly route by Khorassan. The writer expresses his firm conviction that the points of emergence of the choleraic epidemics must be considered as their points of origin. The idea that the different pandemic manifestations of cholera which have depopulated Europe must have invariably come direct from India is no longer tenable. For Europe alone, two striking examples, in 1852 and 1869 respectively, have formally demolished the theories which regarded only things coming from the East as bearing any danger of contamination. The epidemic of 1852 came from within Poland and Germany. That of 1869-73 repeated the same things in Ukraine. Nowadays, when these facts have taken their place in science, some minds seek to diminish their importance by pointing out that these epidemics revived some previous epidemics which had their origin in India. But that which makes the spreading epidemic or the pandemic is the revival of the choleraic principle or germ with all its original attributes. Even in India similar revivals perpetuate the annual endemic, and the epidemics which appear every three, four, or five years. This is the main fact which governs the entire history of cholera, and upon which micro-biological research must proceed. What difference of morphology, of virulence, or of reproductive faculty is there between the germs of the epidemics which die out at their origin, and those of the epidemics which revive several times, and can invade the whole world without proceeding from India?—Application of a conventional system of rectangular co-ordinates to the triangulation of the coasts of Corsica, by M. Hatt. The trigonometrical network drawn for the hydrographic mapping of the coasts of Corsica describes a closed curve. The employment of the conventional system, which transforms into rectangular plane co-ordinates the polar co-ordinates reckoned on the sphere round an origin, offers numerous advantages. The suppression of the sphericity permits the application of processes of calculation which have been dealt with in a preceding communication on rectangular co-ordinates. On this account it was interesting to test on a larger scale the methods which had only been utilised for the determination of secondary points. The experiment has given satisfactory results, and exhibits the practical advantages of the new system of co-ordinates and the methods of calculation. K being the length of the geodetic line joining a point to the origin, and Z the angle made by this line with a fixed direction, the conventional co-ordinates are $x = K \sin Z$ and $y = K \cos Z$. These assumptions permit the rapid and easy calculation of tables of corrections.—On a new hydro-carbon, suberene, by M. W. Markovnikoff.—Action of piperidine and pyridine on the haloid salts of cadmium, by M. Léopold Hugo.

SYDNEY.

Royal Society of New South Wales, June 1.—General Meeting.—Prof. Warren, President, in the chair.—The following papers were read:—Oceanic philology, by Sidney H. Ray; a determination of the magnetic elements at the Physical Laboratory, University of Sydney, by S. Coleridge Farr; on certain geometrical operations, by G. Fleuri; analyses of the well, spring, mineral, and Artesian waters of New South Wales, and their probable value for irrigation and other purposes, by John C. H. Mingaye; remarks on the large sunspots visible at the present time, by H. C. Russell, F.R.S.

July 5.—Chemical and Geological Section.—Prof. Liversidge, F.R.S., in the chair.—The following papers were read:—Microscopic structure of some intrusive rocks in the neighbourhood of Sydney, by Rev. J. Milne Curran; notes on the occurrence of platinum and its associated metals in the Richmond River sands, also in lode material in the Broken Hill district, by John C. H. Mingaye.

July 6.—General meeting. Prof. Warren, President, in the chair.—Paper read:—On the ventilation of sewers and drains, by J. M. Smail.

July 15.—Medical Section.—Dr. Friaschi in the chair.—Paper read:—Recent work on the pathology of cancer, by Dr. G. E. Rennie.

August 3.—General Meeting.—Prof. Warren, President, in the chair.—The following papers were read:—Flying-machine work, and the $\frac{1}{3}$ I.H.P. steam motor weighing $3\frac{1}{4}$ lb., by L. Hargrave. The paper described the experimental work carried out by the author during the past twelve months. A compressed-air-driven flying-machine (No. 16) had no less than twelve trials, on one of which it flew 343 feet, the speed being a little over ten miles per hour. On the first trial it was fitted with a bi-plane, which was found to be a very stable form. Some curious experiments with a segment of a hollow cylinder were recorded. A description was given of a steam engine and boiler for a flying-machine, the total weight of which is $3\frac{1}{4}$ lb., including fuel and water; the indicated horse-power developed was 169. Nine detail drawings were shown, including those of an air-pump and small-pressure indicator. On the venom of the Australian black snake (*Pseudechis porphyriacus*), by C. J. Martin, Demonstrator of Physiology in the University of Sydney, and J. McGarvie Smith.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Euclid, Books 1 and 2: D. Brent (Percival).—Book B: or Arithmetical Chemistry, Part 2, new edition: C. J. Woodward (Simpkin).—Tenth Annual Report of the Fishery Board for Scotland: Part 3, Scientific Investigations (Edinburgh).—Survey of India Department, General Report 1890–91 (Calcutta).—Observations made at the Hong-Kong Observatory in the Year 1891: W. Doberck (Hong-Kong).—Geological Survey Department, Ottawa, Annual Report, new series, vol. 4 (Ottawa, Dawson).—Gemeinverständliche Vorträge aus dem Gebiete der Physik: Dr. L. Sohncke (Jena, Fischer).—The Student's Manual of Deductive Logic: K. R. Bose (Calcutta, Lahiri).—Lightning Conductors and Lightning Guards: Dr. O. J. Lodge (Whittaker).—Horn Measurements and Weights of the Great Game of the World: R. Ward (The Author, Piccadilly).—The Universal Atlas, Part 19 (Cassell). Imperial University of Japan, Calendars for Years 1890–91 and 1891–92 (Tokyō, Maruya).—London Inter. Sc. and Prelim. Sc. Directory, No. 3, July 1892 (London, University Correspondence College).—London Inter. Arts Directory, No. 5, July 1892 (London, University Correspondence College).—A Treatise on Analytical Statics, vol. ii.: Dr. E. J. Routh (Cambridge University Press).—Annual Report of the Department of Mines and Agriculture, N.S.W., 1891 (Sydney, Porter).—The Birds of Lancashire, 2nd edition: F. S. Mitchell (Gurney and Jackson).—Odorographia, a Natural History of Raw Materials and Drugs used in the Perfume Industry: J. Ch. Sawer (Gurney and Jackson).—A Text-book of Agricultural Entomology, 2nd edition: E. A. Ormerod (Simpkin).—Beneath Helvellyn's Shade: S. Barber (E. Stock).—Borneo; its Geology and Mineral Resources: Dr. T. Posewitz, translated by Dr. F. H. Hatch (Stanford).—How to make Common Things: J. A. Bower (S.P.C.K.).—A Short Manual of Inorganic Chemistry: Drs. A. Dupré and H. W. Hake (Griffin).—A Text-book of Coal-Mining: H. W. Hughes (Griffin).

PAMPHLETS.—L'Automobile e la Filosofia Naturale e Sperimentale; Note ed Osservazioni: G. Cassola (Napoli, Gargiulo).—Epidemic Pneumonia at Scotter and Neighbourhood: T. B. F. Eminson (Kimpton).—Contagious Foot-Rot in Sheep: Prof. G. T. Brown (Murray).

SERIAL.—Proceedings of the Liverpool Geological Society, Part 4, vol. vi. (Liverpool).—Natural Science, October (Macmillan).—Traité Encyc. de Photographie, premier suppt.: A. troisième fascicule: C. Fabre (Paris, Gauthier-Villars).—Journal of the Royal Agricultural Society of England, vol. iii. Part 3 (Murray).

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