THURSDAY, OCTOBER 9, 1890.

A NEW THEORY FOR THE SENSITIVE PLANT.

Das reizleitende Gewebesystem der Sinnpflanze. By Dr. G. Haberlandt. (Leipzig : W. Engelmann, 1890.)

THE present decade has been a very important one from the point of view of a botanical revival in this country. The seed sown in previous years by Thiselton Dyer and others did not fall entirely on sterile soil, and gradually a school of active workers has arisen, sometimes described, for want of a better name, as "the younger school of botanists." The individuals constituting this "school," though few in numbers, have pursued widely diverging lines of research ; some devoting themselves to morphology, others to physiology and minute anatomy, others again to the diseases of plants, &c. Important results have accrued from their labours in the various branches taken up, but in no case have they been more striking than in the field of minute cell anatomy. The readers of this journal hardly need to be reminded that the discovery of the continuity of the protoplasm from cell to cell, and the demonstration of the fact that plant tissues do not consist of a number of isolated masses of protoplasm, cut off from one another by the dead cell-membranes, was largely due to the investigations of Gardiner.

The knowledge of the existence of these uniting filaments seemed from the first to throw light on many intricate and obscure physiological problems. Foremost among these was the possibility that by their instrumentality the transmission of stimuli over considerable tracts might be facilitated. It is interesting to remember that almost the first case of continuity of protoplasm demonstrated by Gardiner was that in the pulvini of the leaves and leaflets of the sensitive plant. Nor did this lose its significance when it was later realized that such a continuity was a very general, if not universal, phenomenon in plant tissues. The view that the stimuli, which undoubtedly travel considerable distances in most of the plants endowed with irritable movements, are transmitted in virtue of these exceedingly fine uniting filaments is one very generally held by botanists in this country, and finds expression in Vines's "Lectures on the Physiology of Plants." Indeed, that this is so, in certain cases, has been experimentally demonstrated. In view of these circumstances, the book whose name heads this review, dealing as it does entirely with the mechanism of stimulus transmission, will be studied with interest, and the more so from the fact that Dr. Haberlandt's "Physiologische Pflanzenanatomie" has done much towards the elucidation of many of the facts of anatomy. Dr. Haberlandt here limits himself solely to the investigation of the means by which a stimulus, set up at some point in the sensitive plant (*Mimosa pudica*), is transmitted to a distance, promoting movements in regions far removed from the point stimulated.

During this century various physiologists have busied themselves with this problem, notably Dutrochet, Pfeffer, and Sachs. The prevalent theory on the Continent, which is associated especially with the name of Pfeffer, briefly amounts to this :—When an irritable portion of one of the pulvini of the sensitive plant is stimulated, the irritable cells lose their turgidity, water passing out of them into the intercellular spaces associated with them ; a certain amount of this water is said to enter the tracheides and vessels of the xylem of the vascular bundle, and to upset the hydrostatic equilibrium obtaining there ; this disturbance is transmitted to a distance as a wave in the xylem, and stimulates, as it travels along, the irritable cells of the successive pulvini which it passes near, causing them likewise to contract. This may affect merely the pinnules of a single leaf, or, in certain cases, the stimulus may travel from one leaf to another.

This hypothesis is based on very old experiments performed by Dutrochet more than sixty years ago. Dutrochet found that, (1) after the removal of a complete ring or zone of cortical tissue from the stem, a stimulus could still be propagated from one leaf to another, across the decorticated region. A similar result followed when the pith was destroyed, the vascular bundle alone being left intact. The irresistible inference was that the stimulus travelled by the *vascular bundle*. Further, (2) when the woody portion of the bundle was cut into, a drop of liquid was observed to exude immediately, and a stimulus was transmitted upwards and downwards from the point of lesion, causing movements in the nearest leaves and even travelling to more distant ones. The drop which exuded was supposed to come from the wood, and the disturbance of pressure resulting, to initiate the stimulus. Haberlandt deals with this "fundamental experiment," and shows that Dutrochet and the others were in error. To make this clear, it is necessary to briefly indicate the structure of a bundle and adjacent tissues in *Mimosa pudica*. In a transverse section of a stem (and the same holds generally for the petiole) there is externally the epidermis, below which comes the parenchymatous cortex. The cortex passes over into a zone of thick-walled cells, described as collenchyma by Haberlandt, as bast-fibres by some other writers. Within this thick-walled zone is a ring of phloem, and finally the xylems and pith. Dutrochet, when he thought he had dissected away all the tissues outside the xylem in the experiment recorded above (1), had, in point of fact, left not only the phloem, but also the collenchyma-ring intact. His knife had been arrested by the collenchyma, which he had mistaken for the wood. The collenchyma and phloem remained intact, and the inference that the stimulus travelled by the xylem was consequently a false one.

Further, in the case of experiment (2), Haberlandt is at great pains to show that the drops of liquid do not issue from the wood at all, and establishes the fact that they arise in reality from special cells in the phloem. Following the same method of experiment as Dutrochet, Meyen, and Pfeffer, Haberlandt demonstrates clearly—

(1) That the stimulus normally travels inside the collenchyma ring, but outside the xylem of the bundles ; in other words, in the phloem.

(2) That, when a stem is cut through, drops exude at the moment of cutting. These drops arise, not from the xylem, but from special cells in the phloem.

This alone marks a considerable advance on the older hypothesis.

Having cleared the ground so far, Haberlandt sets himself two problems for solution, and it is with these that the greater portion of his paper is occupied. These questions are :—

(1) What are the special organs in the phloem which transmit the stimulus?

(2) What are the details of the mechanism of transmission?

As his later inferences and experiments are based on a detailed anatomical study of the sensitive plant, it will be advisable to follow Haberlandt into this matter. The phloem of many Leguminosæ is characterized by the possession of rows of cells, somewhat larger than the true sieve-tubes, which, from the nature of their contents, are known as tannin-sacs. These, in *Mimosa pudica*, are long, tube-like cells, arranged end to end. Each cell possesses a primordial utricle and a large nucleus. The longitudinal walls of these cells are frequently pitted, but the structure of their transverse walls is characteristic. Each possesses a very large, shallow pit. The closing-membrane of the pit is traversed by a number of very delicate protoplasmic filaments. These are much finer than the similar connecting filaments of sieve-tubes, and approximate more nearly to the uniting filaments of adjacent parenchyma cells. Haberlandt shows that it is a portion of the watery content of *these* cells which escapes, when a stem or petiole is cut into; and it is his view that these cells constitute the organs which transmit the stimuli from one point to another in the plant. The watery fluid which exudes from them, usually clear and colourless, gives a very characteristic, and deep reddish-violet colour, with iron chloride, and, if allowed to dry upon a slide, crystallizes out in various forms, usually arranged as sphere crystals or dendritically. This substance is probably of the nature of a glucoside, since, among other reactions, when treated with acids it is broken up into glucose and a resinous body. Accompanying this glucoside is a considerable amount of mucilage.

The distribution of the vascular bundles, in especial relation to these supposed conducting cells, both in leaf and stem, is followed out in detail. The glucoside-containing cells occur, roughly speaking, in two rings in the phloem, one of which is nearer the collenchyma zone, the other nearer the xylem. Some of the former actually touch the collenchyma cells. Where the bundles traverse the pulvini, a much larger proportion of these cells are in contact with the collenchyma. In the leaflets all the larger bundles are accompanied by the glucoside-containing cells, but in the very small anastomoses they die out. Finally, as to the distribution of protoplasmic continuity. This obtains in the soft cortex and in the collenchyma (whose cells are freely pitted). The cells of these two tissue systems are united together by extremely fine filaments in such a manner that an unbroken protoplasmic continuity exists, from the periphery of the pulvinus to the inmost layer of the collenchyma. In the phloem also there exists a similar continuity. Between these two systems, however—the soft cortex and collenchyma on the one hand, and the phloem (including the glucoside cells) on the other—there is, according to Haberlandt, no direct continuity; and although the collenchyma cells are freely pitted on all sides, the closing-membranes of these pits are untraversed by protoplasmic filaments on the side directed towards the phloem (and glucoside cells).

By careful experiments, referred to above, Haberlandt demonstrates (what had been regarded by several observers as probable) that the stimulus travels in the phloem; and in view of the fact that the glucoside sacs emit the drops of liquid on cutting a stem or petiole (thus giving rise to a hydrostatic disturbance), and in view also of inferences drawn from further experiments, to be considered immediately, Haberlandt concludes that the stimuli are transmitted by the rows of glucoside-containing sacs, and this in a purely mechanical manner. Before going on to elaborate his theory, Haberlandt meets and disposes of the hypothesis, mentioned at the commencement of this review, that the stimuli travel from cell to cell by the agency of the uniting filaments of living protoplasm. According to that view, when any pulvinus is stimulated, as by a mechanical shock, its irritable cells contract, losing their turgidity, and a movement results; at the same time the stimulus would be conveyed to the phloem, and there transmitted from cell to cell by the filaments of protoplasm (it is immaterial whether in the phloem-parenchyma, or even in the longitudinally-running series of glucoside sacs) until it reaches another pulvinus, where it would be communicated in the same way to the irritable cells there, and a further movement would result, and so on.

It is necessary at this juncture to explain, so as to make what follows intelligible, that physiologists have availed themselves of two entirely different methods of stimulating the plant—firstly, by submitting a pulvinus to a mechanical shock, without damage to its tissues; and secondly, by cutting the petiole or stem, and causing actual lesion of the conducting tissues. In both cases the stimulus is transmitted, but in the latter to a much greater distance, the method being altogether a more violent one and perhaps quite different in its effects. Pfeffer was content to regard anything of the nature of a "vital" hypothesis of stimulus-transmission as disproved, from the fact that, even when he chloroformed a definite portion of a petiole, a stimulus could still be transmitted through the region subjected to the chloroform. Haberlandt, however, points out that this result must not be taken as final, since there is no proof that the internal tissues had been really acted on by the anæsthetic, as applied by Pfeffer. Further, Vines has pointed out that, although chloroform deprives the *irritable cells of the pulvinus* of their irritability (rendering them rigid), there is no justification for the assumption that it likewise deprives the protoplasm of the *conducting cells* of their conductivity; an objection the validity of which is admitted by Haberlandt. It was necessary, therefore, to make a more crucial experiment to decide this point, and this Haberlandt does by substituting an *actual killing* of the protoplasm in a small portion of a petiole for a mere chloroforming. This was done by steaming a confined zone of a petiole. Under these conditions, the stimulus, to be transmitted successfully, had to pass through a dead region. If the stimulus could be shown to traverse this region, the "vital" hypothesis would be untenable. The

result was most instructive. When an ordinary mechanical stimulus was applied, there was no transmission; when, however, a stimulus, caused by a lesion of the tissues, was applied, it was transmitted, in the majority of cases, over the zone previously killed by steam. From this, Haberlandt concludes that no theory which depends on filaments of protoplasm to conduct the stimulus can be maintained. He considers it improbable that a mechanical stimulus and one due to lesion should travel in different ways, notwithstanding the fact, which he mentions later on, that under special conditions a stimulus can be transmitted even by the vessels and tracheides of the xylem. There is nothing surprising in the transmission over a dead region of a stimulus due to lesion. It is just this sort of stimulus that would cause a considerable upset in the hydrostatic equilibrium in the glucoside cells cut into, and it is conceivable that the disturbance due to this sudden fall in pressure might be conveyed, in a purely mechanical manner, over considerable distances. Hitherto it has not been shown that a *normal mechanical stimulus* can be transmitted over a zone that has been rendered incontestably dead.

If the distribution of the continuity of protoplasm in a pulvinus should be, as stated by Haberlandt, such that the outer system of continuous cells extends inwards only so far as, and including, the collenchyma, and that the phloem is independent of this system, then it is difficult to see how the stimulus could pass (by a vital hypothesis) from the irritable and contractile cells to the conducting cells. This result, however, requires confirmation. Gardiner, who investigated the nature of the continuity in these organs of the sensitive plant, makes no comment on any such marked discontinuity of the protoplasm, and the inference, drawn from a study of his paper in the Philosophical Transactions, is that the cells, from the periphery right up to dead vessels of the wood, constitute one connected whole. What he denies to the sensitive plant, Haberlandt admits for other cases. The phenomenon of transmission of stimuli in the stigmas of *Mimulus* and *Martynia*, in the leaves of *Dionæa* and probably of *Drosera*, and in the tendrils of many climbing plants, would seem to be a function of the protoplasmic fibrils. Having dealt with his refutation of the "vital" hypothesis, as applied to the sensitive plant, we may give a short summary of the theory put forward by Haberlandt, though for its details, and the many questions raised therein, the reader is referred to the original text. Haberlandt holds that both in the case of a mechanical stimulus, and in that of one caused by a lesion of the tissues, the transmission is effected in a purely mechanical manner, as a wave or impulse passing along the glucoside-containing cells. Necessarily the transverse walls, which possess each a broad, shallow pit, are regarded as offering little resistance to the filtration of the contained sap. The protoplasm which is continuous through these pit-membranes is not regarded as playing any important part in this event. When a pulvinus is mechanically stimulated, its irritable cells lose water and contract; the disturbance set up by this fluctuation in pressure will start a wave in the rows of conducting cells, travelling from the point at which the increase of pressure occurs. The wave is what may be described as a positive wave (*Bergwelle*), and the method of its transmission is similar to that obtaining in a closed rubber tube distended with water, when it is pinched at one end. This wave, when it reaches the irritable cells of the next pulvinus, will be communicated to them through the elastic collenchyma layer, probably through the pits, which are numerous. In more sluggish cases it may not, perhaps be till an actual *bending* occurs in the stimulated pulvinus that the increase of pressure will be sufficient to start the wave in the conducting cells.

On the other hand, when the stimulus is due to lesion, as when a petiole or internode is cut into with a sharp knife, the wave is set up in a different manner. At the moment of cutting into the turgid, glucoside-containing cells, a drop of liquid escapes, causing a *fall* in pressure. This is transmitted as a negative wave (*Thalwelle*), and will be communicated to the irritable cells at a distance, by the agency of the pits there. In this case, however, the pit-closing membranes of the collenchyma will bulge slightly inwards, in the former case outwards. The communication from the conducting to the contractile cells is rendered easier from the fact that in the pulvinus a much larger proportion of the former lie adjacent to the collenchyma than at other points on the course of the bundle. This special arrangement undoubtedly seems to favour such a theory as that of Haberlandt. Still it must be remembered that it may be due to quite different causes. As is well known, the arrangement of the bundles is always considerably modified at the pulvini, so that the bending may be interfered with as little as possible.

In conclusion, it must be admitted that the paper here reviewed is a masterly piece of work, though, it may be, many naturalists in this country will hardly agree with the author in the inferences which he draws, and the theory which he builds upon them. It must be borne in mind that possibly too important a part may have been assigned to the uniting fibrils of protoplasm as touching the transfer of stimuli of various kinds from cell to cell. In the first blush of a great discovery, of so far-reaching a nature as that of the continuity of protoplasm, and more especially from the fact that at a very early period it was in the sensitive pulvini that this continuity was shown to exist,—in view of this, the position that has been taken up by workers in this country may have been an oversanguine one. It may be that the explanation of this phenomenon of protoplasmic continuity (though undoubtedly it facilitates transmission of stimuli in certain cases, *e.g.* stigmas of *Mimulus*, &c.) may have another bearing—that it may in some way affect the nutrition of the pit-closing membrane, or even discharge the purely mechanical function of binding the protoplasts to the closing membranes. For the present, although it must be conceded that Haberlandt has considerably advanced our knowledge of this question, in that he has localized the conducting region to the phloem, and has shown that stimuli due to actual lesion can be transmitted in a purely mechanical manner; nevertheless he has failed to demonstrate conclusively the untenability of the "vital" hypothesis in the case of the normal stimulus (*Stossreiz*). This being so, further results must be awaited before this interesting question can be regarded as finally settled.

F. W. O.

CHRISTY'S "BIRDS OF ESSEX."

The Birds of Essex: a Contribution to the Natural History of the County. By Miller Christy, F.L.S., 8vo. (Chelmsford and London : 1890.)

"HITHERTO," truly observes the author of this work in his Preface, "the birds of Essex have not found a chronicler. It is to supply this omission that I have laboured." The omission has indeed been long regretted, and every page of his book shows that Mr. Christy has laboured hard to supply it, so much so that it would seem an act as ungenerous as it is certainly unpleasing to find any fault with him for the way in which he has performed his task; but the duty of a reviewer is one neither to be lightly entered upon nor lightly executed, and misplaced tenderness may easily be as harmful in a critic as in a surgeon.

There is fortunately in these days no need to dwell on the advantage of county ornithologies—even the worst of them is better than none at all. Mr. Christy's is very far from being among those that are bad; but it does seem to us that more skilful treatment would have secured for Essex a less insipid result than he has given us; for the county of the greatest English naturalist should surely present a more becoming figure than here appears. Its geographical position, its sufficiently varied natural features—and among them especially its wealth of estuaries, so grateful to scores of graceful birds—seem to point it out as one of the most favoured parts of the kingdom. We can hardly admit the value of Mr. Christy's supposition (pp. 2, 3) that—

"If only our illustrious Ray had made some attempt to produce a list of local birds, similar to that of his contemporary, Sir Thomas Browne, there is no saying how many practical Essex ornithologists it might indirectly have brought out, or to what a pitch of ornithological eminence the county might by this time have been raised."

When will naturalists think the history of their study worth studying? Nothing can be more certain than that the now celebrated "Account of Birds found in Norfolk," by Sir Thomas Browne, remained in manuscript until printed by Wilkin in 1835; and, while very few could have been aware of its existence, fewer still could have read its crabbed handwriting. As a matter of fact, we believe it was unknown to every ornithologist until it was published. On the other hand, Mr. Christy shows that almost from Ray's time to the present day Essex has not been wanting in observers of birds, who really seem to have had it in them to do as much good work as those of the not very distant and more northern county, whom he evidently and not unjustly regards with a kind of modified envy. But our author may get some comfort by looking southward across the wide Thames, and there contemplating in a still nearer neighbour a county whose ornithology, as we have before remarked in these columns, is yet unwritten as it should be.

Mr. Christy rightly remarks that "some detailed attempt" to describe the physical features of every county or district should be an essential part of each local "avifauna," but he unfortunately favours us with barely three pages of such description. Now we are sure that he might have told us a good deal more on this subject that would have been well worth knowing. He divides his county into *five* districts, which is doubtless well enough, if we can forgive the incongruity of the last:—(1) The Chalky Uplands, (2) The Lowlands, (3) The Forests and Woodlands, (4) The Marshes and Saltings, (5) The Open Sea! The first of these, a very small but well-defined area, has probably, through enclosure and tillage, undergone more change within the last 70 or 80 years—or even less—than any of the rest; for the second has been highly cultivated for centuries, and the third—though Mr. Christy thinks that strictly speaking it cannot be separated from the second—in some sort possesses the appearance it must have worn (if not the fauna it harboured) in the middle ages when, if we may believe the chroniclers, the citizens of London went forth to slay wild bulls and wild boars within its precincts—a trace of the practice being retained in the "Epping Hunt" of Easter Monday, which some of us are old enough to remember, and others may be reminded of by Hood's comic verses. But the fourth of Mr. Christy's districts may be considered the most characteristic of Essex, and we think he might advantageously have told us much more about it, especially about the islands—if islands, except in popular speech, they may be rightly called—into which the land, as it were, breaks up—Canvey, Foulness (a most suggestive name), Osea, Mersea, and others. One would think they cannot be all alike, and would like to know wherein they differ. The same may be said of the rivers—and the rivers of Essex are rather fine things in their way; the many-mouthed Crouch is not exactly similar to the spacious Blackwater, any more than is the narrow Colne (in happier times glorying in its abundance of "natives") to the lake-like Stour, which the county shares with Suffolk. As to the fifth district, only a technical objection could be raised, and that would be against the use of the epithet "open." A maritime county must have a sea-border, and it stands to reason that a fair portion of the adjacent salt water should be regarded as *adscriptus glebæ*, but no attempt is made to define that portion. Considering the shallow soundings off the Essex coast, perhaps the political "three mile limit" might be the best to choose; but again, considering the paucity of bird-life in the summer time in this narrow sea, and the knowledge that in winter one part of it is nearly as good as another, this does not much matter, and if Mr. Christy would extend his survey to the halfway line between England and Belgium, there is none to take exception thereto. In truth Essex, owing to its want of cliffs—for there is nothing save near Walton-on-the-Naze entitled to be so-called—and of beaches, such as those of Orford or Dungeness possessed by its neighbours, has nowadays nothing except the Little Tern,[1] that can be called peculiarly a shore-bird, for he properly denies (pp. 100, 101) the claim set up by the late Dr. Bree for the "Mud-lark" (*Anthus obscurus*), and, as all ought to know, the Ringed Plover will breed far inland; but we think he has missed an opportunity in not applying to the Migration Com-

[1] There can be hardly a doubt that the Common and perhaps the Sandwich Tern bred formerly on the Essex coast, but everyone knows how easily a settlement of either may be destroyed in a few hours by some heedless person who thinks himself a sportsman or a naturalist—so that all around our shores both species are being yearly extirpated from spot after spot. Mr. Christy's evidence (pp. 261, 262) as to the Black Tern, not that it is littoral species, breeding in the county, amounts to nothing if properly scrutinized.

mittee of the British Association for the schedules filled up by the light-keepers on the coast of his county. The necessary documents would doubtless have been readily placed at his disposal, and comparatively meagre as the results might have been, they would certainly have enabled him to give a considerable amount of additional information.

Like most of his fellows, Mr. Christy attaches an undue value to the number of species he is able to register, and his number is 272. We have often wished there would arise some strong-minded man who would clearly distinguish between a member of a fauna and a fortuitous straggler. Still, we gladly allow our present author to be more discriminative than many of his brethren, and highly applaud his exclusion of several species which they, or some of them, welcome—yet he more than once bows the knee to the prevailing Baal. It is bad enough for any British faunist to admit one species of Sooty Tern, especially when the alleged single specimen rests on authority not quite beyond suspicion, and, though not ten years have elapsed, has been "entirely lost sight of"; but the inclusion of a second species dulls one's feelings, like an anæsthetic—especially when we are told that in this case it is the captor "who has since been lost sight of" (p. 261), though the specimen is (apparently) to the fore. Then, again, what can be more absurd than the admission of *Porphyrio smaragdonotus* (p. 225)—a species of which living examples are yearly imported in great numbers, and one that possesses faculties of escaping from confinement that would have been envied by a Casanova or a Baron Trenck.

It may be urged that we have picked out trifling faults, but we could reply that we have purposely chosen these instances to show two at least of the failings of faunists. Others we might specify of a rather different kind. It is a remarkable fact for ornithologists in general that the Needle-tailed Swift should have flown across the Old Continent from Eastern Siberia to Essex, but that fact does not make it a "British" bird, and the late Mr. Yarrell—generally too prone to naturalize all stragglers—was in our opinion perfectly justified in refusing it a place in his well-known work, while even the subsequent occurrence of two examples in Hampshire does not affect his rejection of it. As regards the inclusion of "stragglers," the line is in many cases hard to draw, but in one such as this there ought to be no doubt in the mind of anybody who has a decent acquaintance with the geographical distribution of animals.

The present work differs of all others of its kind in two respects, and one of them is deserving of much praise. This is the useful "Biographical Notices of the principal Essex Ornithologists," which are greatly to the point, and generally, as appears to us, well done, though Mr. Christy is somewhat lavish of the expression "excellent ornithologist." That would doubtless be applicable to John Ray, who is not included, but in its literal sense to few if any others. Yet men like Sheppard, Hoy, and Henry Doubleday were worthies who left their mark on British natural history, and fully merit all that is said of them, while Christopher Parsons seems to have been one of those diligent observers who delight in hiding their candle under a bushel, and we feel under an obligation to Mr. Christy for bringing him out of obscurity.

Of the other distinctive feature of the work we cannot report so favourably. It is the needless introduction of a considerable number of figures representing the birds mentioned. Some of them, it is true, are reproductions of Bewick's well-known woodcuts, and therefore right in the main, however poor the imitation. Next, if not equal to them, are the few drawn by Mr. Wolf; but the adaptations of the engravings from Yarrell's work, if they cannot be called absolutely bad, are objects about as disagreeable as one ordinarily encounters, and there are others, the source of which we cannot divine, that make one shudder, for the draughtsman has evidently copied too faithfully (as the manner is nowadays) the distortions of the bird-stuffer—as witness the figure of the Swift (p. 144), which reminds one forcibly of the impossible tenants of the air in the familiar willow-pattern plate.

To sum up, let us say that with all its shortcomings Mr. Christy's book is one that must demand the attention of every British ornithologist, for it "means business." There is no attempt at fine writing in it, and yet its composition has clearly been a labour of love to the author. We trust he may be rewarded by a successful sale, which the populous county of Essex ought to insure, and be able to bring out a new edition. If so, let him eschew his woodcuts, and in their place give us more large type.

HYPNOTISM.

Hypnotism. By Albert Moll, of Berlin. "Contemporary Science Series." Edited by Havelock Ellis. (London: Walter Scott, 1890.)

THIS book by Dr. Albert Moll, a physician of Berlin, on hypnotism, now presented to us in a becoming English dress, marks a step of some importance in the study of some difficult physiological and psychological problems which have not received much attention in the scientific world of England. The appearance of a text-book on any subject in a set of hand-books such as the "Contemporary Science Series," indicates a general agreement on the main points of knowledge, and in this case a full admissal of the subject to the category of recognized science. Dr. Moll's work has already been widely accepted as a text-book in the German schools which are beginning to take some interest in his subject. The first edition was published hardly eighteen months ago, and was very rapidly exhausted; the second, from which this English translation has been made, shows good proof of the diligence and care of the author, in the large amount of new matter incorporated with the old, so that on the whole it is well up to date, a matter not so easy to accomplish in treating of a rapidly growing subject such as hypnotism, on which nowadays there are published some 300 books, pamphlets, and articles every year. There has often been in this crowd of minor literature of late years a tone of somewhat indignant, sometimes injured self-assertion, such as is not unnatural to the friends of a young branch of knowledge, who are anxious and perhaps over-anxious to establish its position on equal terms with its seniors. But Dr. Moll's hand-book embodies an essentially non-combative survey of the full breadth of the subject, including both the details of the physical and physiological conditions of hypnotism on the one side, and on the other the alterations of personality and the more delicate points of

psychological interest; and it does not refuse to consider with some careful attention the phenomena of telepathy and thought transference in a hypnotic state, such as are judged by Charles Richet, Gurney, Pierre Janet, Oliver Lodge, and others to take place under conditions which render their explanation by the action of the known senses at present inadequate.

Such a comprehensive review of the present position is in need of a far more extensive and careful historical preface than is usually undertaken; and in this respect Dr. Moll has shown his sense of his responsibilities, and gone much beyond a mere reproduction of the hackneyed account of many of the French writers. He sees that the phenomena generally called mesmeric did not entirely originate with Mesmer (1734–1815), about a century ago; but can be in part traced back to some of the earlier civilizations (cf. Ebers's papyrus, 16th century B.C.), and assumed some of their more modern forms under Paracelsus (1493–1541) and van Helmont (1577–1644), although, of course, their recent growth has been far more rapid. Mesmer is a man hard to estimate rightly. The final account of him has probably not yet been written, nor the final judgment passed, but Dr. Moll furnishes a sketch of some discrimination, based chiefly on contemporary evidence, and showing some sympathy for the mental and moral bewilderment occasioned by the chaos of the Great Revolution with which he was surrounded in Paris. Since Mesmer, he realizes the steps in advance made by Braid (1843), in recognizing the physiological and psychological importance of a state of attention in what he called no longer mesmerism or animal magnetism, but hypnotism; by Esdaile in 1845, in demonstrating the complete anæsthesia that was made possible by hypnotism, even in major surgical operations; by Liébeault (1866), in showing the practical use of post-hypnotic suggestion to dominate at least some morbid habits and minor pains; and by the schools both of the Salpêtrière under Charcot (1878) and of Nancy under Bernheim (1884), in proving to the general public the permanent importance of a deeper study of the subject.

The survey of the methods of induction and the symptoms of hypnotism is founded on much personal experiment and a wide experience in all the European nations. More than 600 authors are quoted, and more than half of these are contemporary. Though fully half of them come from France and Germany together, yet there is a very considerable total of English, Swiss, Austrians, Americans, Italians, Spaniards, Belgians, Dutch, Swedes, Danes, Greeks, and Russians. Hypnotism is certainly not a limited or local fancy. Last year the four days' discussion of hypnotism under its various aspects at the Congrès International de Psychologie Physiologique, in Paris, by such a large gathering of men from all parts of Europe, not interested merely in the medical side of the subject, but in its total results and their relation to other branches of knowledge, gave very tangible proof of this, as may be seen in their *Compte rendu*. And who are the easiest persons to hypnotize? It is very common to find those who have had little or no experience themselves confident that they can point out the most amenable subjects, and choosing generally persons with some obvious weakness. But Dr. Moll shows that neither neurasthenia nor hysteria, nor weakness of will, nor any of the sentimental weaknesses that may be made to render their subjects laughable, really conduce to making them more readily hypnotizable. Hysterical people may be morbidly imitative, and if one is hypnotized many may follow the example, if it is open to their observation; but taken singly, their hysterical tendencies rather hinder than help their hypnotization (p. 316), a point which has unfortunately been rather obscured by the long and important experiments made by Charcot on the hysterics only; for, from the success of many of these, it was hastily and incorrectly assumed, before wider trial, that this class of subject was the most easily influenced. Whether there can be any special capacity in the hypnotizer is a point Dr. Moll does not discuss in detail; he assumes that all of fairly good intelligence are about equal after a little practice at the *technique*. But there are some cases which he mentions (p. 363), of hypnotism at a distance by Dr. Gibert and Pierre Janet, in which, when both the persons hypnotizing and the times of hypnotism were unknown to the subjects, certain persons proved pre-eminently successful (*Bulletins de la Société de Psychologie Physiologique*, 1886, p. 78). The proof or disproof of individual qualifications is, in fact, one of the many difficult points for the settlement of which a wide and very careful experimental research is still necessary. The mesmerists of the early part of the century can be shown to have laid too much stress upon it; it may be that it is too much overlooked now.

Any exact definition of hypnotism, as of other abnormal states of consciousness, is difficult enough, as Dr. Moll very readily acknowledges. "The two characteristics of hypnosis are suggestibility and the power of ending the state at pleasure" (p. 208), he observes, in agreement with most others who have considered the subject; but it is not plain how this is consistent with what he has said just before (p. 201), viz. that "to my mind the dividing line between sleep and hypnosis is merely a quantitative difference in the movements." The mental susceptibility would have seemed to us a more important point of variance. But we are glad to say that, on the more difficult points of theory, Dr. Moll promises us another book at some future date, and it seems wise to allow some considerable time for the collection and attestation of the phenomena before attempting the establishment of theory in matters of such traditional difficulty.

That the practice of hypnotism is very useful in the healing art Dr. Moll is convinced, and offers a good deal of technical medical evidence which it would be hardly appropriate to consider here. The power of post-hypnotic suggestion in checking habits of drunkenness, &c., is one which is just beginning to be confirmed from various quarters, and which opens a wide vista. The possible dangers which arise from the hypnotist's power over the patient's conduct need very careful attention, though Dr. Moll is inclined to point with satisfaction to the very few cases in which any injury has been actually done. We could have wished that he had made plainer that most important preventive practice of Liébeault's, viz. that those who are afraid of the dominion of any hypnotist can be and should be protected against it by hypnotization under other trustworthy hands, and by the suggestion that no one can have any hypnotic or post-hypnotic power over them. In his last chapter on

animal magnetism, Dr. Moll practically admits an unexplained residuum of facts, and in the candid temper of his whole book, shows a truly scientific spirit of genuine interest in their investigation.

A. T. MYERS.

OUR BOOK SHELF.

Text-book of Mechanics. By Thomas Wallace Wright. (New York: D. Van Nostrand Company, 1890.)

THIS book is a most excellent treatise on the science of mechanics, and systematically places before the student the principles which underlie the subject. The differential calculus for the most part is used only when a clear advantage is gained by it, and in the earlier chapters of the work two courses are open to the reader, one with and the other without it. The author in a note rather regrets that words for the unit velocity and unit acceleration have not been proposed, as these would simplify matters: the Rev. J. B. Lock, in his late book on "Dynamics for Beginners," has proposed and used two very good words, "velo" and "celo," for unit velocity and unit acceleration respectively.

On the whole, the practical parts are treated more fully than is usual, and the examples throughout are of a very practical and typical character, and not mere numerical illustrations of formulæ. Many examples the author has treated by the graphical method of solution, but he adds a word of warning to the student against making it a complicated weapon for attacking all sorts of problems which are more easily solved in other ways.

Another important point alluded to is the use of approximate formulæ: the rigorous formula always precedes the approximate one, the latter being reduced from the former, so that the degree of approximation can easily be estimated.

The last two chapters deal with the statics and kinetics of fluids, or, as they are more generally known, hydrostatics and hydrokinetics.

Besides numerous examples there are plenty of figures and woodcuts, and scattered here and there are a few historical notes which give a lively interest to the subject.

W.

An Elementary Text-book of Heat and Light. By R. Wallace Stewart, B.Sc. London. (London: W. B. Clive and Co., 1890.)

THIS volume is one of the University Correspondence College Tutorial Series, which are written specially to meet the requirements of the various London University examinations.

Of the twenty chapters, the first ten deal with the principles which underlie the theory of heat, while the second ten treat of those of light. In each chapter the principles and laws on which the subject-matter depends are fully described, and under the heading of "Calculations" the author explains the various laws in mathematical form, concluding with examples worked out, and in many cases questions from well-known examinations. The chapters on light are treated in a similar manner. Those reading this work should be able to obtain a fair grip of these two subjects, the elementary principles being well and concisely expressed.

At the beginning of the second part of the book, on "Light," the author recommences the numbering of the pages, which we think is rather a mistake, as it is awkward in the first instance for reference, and in the second it has necessitated the use of two indexes. The illustrations, one hundred and fifty in number, are very good and accurate, and the work concludes with an appendix containing a paper of questions set at the London Matriculation examinations under the new 1888 regulations.

W.

The Confessions of a Poacher. Edited by John Watson, F.L.S. (London: The Leadenhall Press, 1890.)

IN an editorial note it is stated that the poacher of these "Confessions" is "no imaginary being." Since that is so, it might have been well for Mr. Watson to explain the precise nature of his own functions as editor. It seems rather odd to find a poacher talking in this way:—"It was the fact that I had, during the small hours of the morning, stood alone on London Bridge. The great artery of life was still; the pulse of the city had ceased to beat. Although bred among the lonely hills, I felt for the first time that this was to be alone; that this was solitude. I felt such a sense as Macaulay's New Zealander may experience when he sits upon the ruins of the same stupendous structure." How much of this is the poacher's, and how much are we to attribute to the editor? The same question often suggests itself, and a good many readers, we suspect, will conclude that at least with the form of the "Confessions" the person supposed to be confessing has had very little to do. The book displays a curious and intimate acquaintance with some forms of animal life, and may be of service in fostering a liking for natural history. Unfortunately, however, grammatical rules are not always treated with the respect which is due to them. Says the poacher: "Whilst preparing my nets and wires, the dogs would whine impatiently to be gone." No doubt the poacher here means that he himself prepared his nets and wires, but what he says is that the dogs prepared them.

Examination Papers in Trigonometry. By George H. Ward, M.A. (London: George Bell and Sons, 1890.)

ONE hundred and twenty examination papers are given in this book; they are arranged progressively and seem to be well chosen, and will be found good substitutes for the questions in the various text-books which become familiar to the student on his second reading. Questions solely on book-work collected together at the end form a useful addition.

Blackie's Modern Cyclopædia. Vol. VII. Edited by Charles Annandale, M.A., LL.D. (London: Blackie and Son, Limited, 1890.)

THIS is the seventh volume of this useful and valuable essence of information, commencing with the word "Potamogeton" and reaching as far as "Skates." The articles on the various subjects are generally well treated, and every reader may find something of interest in them; numerous pictorial illustrations and maps are given. The references to printing, Prussia, railways, Rome, Russia, and Scotland are among the most lengthy in this volume.

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.*]

Recent Classification of the Shrews.

DURING the present year some very important work has been done with the *Soricidæ*, the family of the Shrews. This has been mainly contributed by the well-known student of the group, Dr. George E. Dobson, F.R.S., the distinguished mammalogist. Dr. Dobson has just published the first fasciculus of Part III. of his work entitled "A Monograph of the Insectivora, Systematic and Anatomical" (Gurney and Jackson, London). This fasciculus deals entirely with the Shrews, it being a quarto illustrated by six fine lithographic plates fully illustrating the dentition of the *Soricidæ*, as its text, in the most admirable manner, presents their characters. Even a still more important paper by the same author appeared in the Proceedings of the

Zoological Society of London for February of the present year, and is entitled "A Synopsis of the Genera of the Family *Soricidæ*." Probably the most extensive collection of these interesting little mammals ever examined by a single investigator, came under the hand of the writer of the works just quoted, wherefrom to make his deductions. His classification is most complete and acceptable, and goes to show that the Shrews are first to be divided into two sub-families, viz. the *Soricidæ*, and the *Crocidurinæ*, the first being characterized by having their teeth red-tipped, while in the latter the teeth are white. Five genera make up the first sub-family—which stand, *Sorex*, *Soriculus*, *Blarina*, *Notiosorex*, and *Crossopus*. In the *Crocidurinæ* we find six genera—namely, *Myosorex*, *Crocidura*, *Diplomesodon*, *Anurosorex*, *Chimarrogale*, and *Nectogale*. This adds four genera to M. Milne-Edwards's list, and from the same omits the genus *Neosorex*. Dr. Dobson believes that "the red-toothed Shrews diverged from the white-toothed, development having proceeded on somewhat similar lines in the descendants of both according to similarity of environment and modes of life." Of Dr. Merriam's genus and type, *Atophyrax bendirii*, he says that "there are no leading characters which would enable one to define the genus, were I inclined to admit it in my synopsis."

It is refreshing in these days to meet with such classification, and such an able classifier—one who, as Dr. Dobson most emphatically does, draws good strong lines in taxonomy, and discourages the hair-splitting methods adopted by some mammalogists in these days. R. W. SHUFELDT.

Takoma Park, D.C., September 13.

Musical Sands.

IN reference to the note respecting Mr. Hyndman's query *re* sonorous sand (NATURE, October 2, p. 554) it may be interesting to him, and others, to know that in our own islands musical sand is by no means rare. In the second edition of my "Musical Sand," shortly to be issued, I shall give a list of the places at which it occurs in England, Scotland, Ireland, and Wales, showing that only *observers* are rare—not the sands.

My investigations since my paper was first published nearly two years ago have brought many new and interesting facts under my notice, not the least being that the musical sands at Studland Bay are always mute during an easterly wind. This I have been able to account for.

About three years ago I propounded a theory to account for the emission of these musical sounds from sands; briefly it is that they are the result of the rubbing together of millions of clean sand-grains very uniform in size: two such grains rubbing together would not produce vibrations audible to us, but the *accumulation* of such vibrations issuing from millions of surfaces, and, approximately, of equal length, would produce a note sufficiently powerful to be sensible to us.

This theory has long been published, and though it has been examined by some of our most eminent physicists, and tested in a variety of ways since, nothing has been suggested which has caused me to abandon it. I shall be pleased to send Mr. Hyndman a copy of my first paper on the subject.

Bournemouth, October 6. CECIL CARUS-WILSON.

With what Four Weights (and a Pair of Scales) can be Weighed any Number of Pounds from 1 to 40 inclusive?

WITH two weights four amounts can be weighed, viz. each weight and the sum and difference of the two.

With a third, in addition to these four, the sum and difference of each and the third can be weighed. Three weights therefore give 13 amounts. Similarly a fourth weight gives $13 + 2 \times 13 + 1$, or 40 amounts, exactly.

It is therefore evident that each amount must be arrived at by only one combination, and that the sum of the weights must be 40 pounds. To weigh 39 pounds, then, we shall clearly want a 1 pound weight. With 1 and 39 we can weigh 1, 38, 39, 40. For the next weight 2 clearly will not do, as 1 could be arrived at in two ways. Taking 3, we find that 1, 3, and 36 give us 1, 2, 3, 4, 32, 33, 34, 35, 36, 37, 38, 39, 40. Now to get 5 without getting any amount by more than one combination we clearly want 9, and this will be found to solve the question, the weights being 1, 3, 3^2, 3^3. A fifth weight of 3^4 will enable us to weigh any number of pounds up to 121, and so on.

E. R. F.

Protective Coloration of Eggs.

IN view of Mr. Grensted's letter to NATURE last year (vol. xli. p. 53), asserting the writer's belief that the egg of the red-backed shrike varies with the tint of the lining material of the nest, and of my own reply to this (same volume, pp. 129–30), I had intended this summer to examine as large a series of nests and eggs as possible, in order to verify or disprove my former observations. I have, however, been unable to devote any time to the matter; and have only obtained two nests—both from the neighbourhood of Evesham. In each of these, I must confess that Mr. Grensted's contention is borne out. The lining of one nest is dull brown in colour; and the eggs (5) are of a mouldy-brown ground-colour, tending towards dull green. The lining of the second is brighter in tone; and contains a small fragment of red flannel. The eggs (5) of this nest show the commoner flesh-coloured ground.

In spite of these two instances, I must hold to my former opinion, that the correlation of ground-colour and environment is very imperfect in the nests and eggs of these birds. Next year I hope to be able to examine a greater number of nests.

E. B. TITCHENER.

Mote House, Mote Road, Maidstone, October 2.

LUNAR PHOTOGRAPHY.

THE idea of employing the process invented by Daguerre and Niépce for the purpose of obtaining photographs of our satellite was first suggested by Arago in a report made to the Paris Academy of Sciences on August 19, 1839. Daguerre acted on the suggestion, but, in spite of a long exposure, he obtained only feeble impressions, in which all details were conspicuously absent (Arago, "Œuvres," vol. vii. p. 458). The first photographic representations of the moon may therefore truly be said to have been made by Dr. J. W. Draper in America by means of a Newtonian reflector of five inches aperture. The specimens were presented to the New York Lyceum of Natural History. The following is an extract from the minutes of that association:

"March 23, 1840. Dr. Draper announced that he had succeeded in getting a representation of the moon's surface by the daguerreotype. . . . The time occupied was 20 minutes, and the size of the figure about 1 inch in diameter."

Dr. Draper also wrote in September of the same year:—

"There is no difficulty in procuring impressions of the moon by the daguerreotype beyond that which arises from her motion. By the aid of a lens and a heliostat, I caused the moon-beams to converge upon a plate, the lens being three inches in diameter. In half an hour a very strong impression was obtained. With another arrangement of lenses I obtained a stain nearly an inch in diameter of the general figure of the moon, in which the places of the dark spots might be indistinctly traced" (*Phil. Mag.*, vol. xvii. p. 222, 1840).

In 1850, W. C. Bond, in conjunction with J. A. Whipple, a photographer of Boston, obtained some really good daguerreotypes of the moon. The instrument used was the equatorial of 15 inches aperture belonging to Harvard College Observatory, and images from two to three inches in diameter were obtained on plates adjusted at its focus. Some of these pictures on glass, and mounted for the stereoscope, were exhibited in London at the Great Exhibition of 1851, and also at Paris ("Annals, Observatory of Harvard College," vol. i. p. clvii.).

Also in 1850, Niépce de St. Victor obtained a strong impression of the full moon in twenty seconds on an albumenized glass plate sensitized with silver chloride. He had only discovered this photographic process a few months previously, and the plate was exposed in order to test the efficiency of the film employed. No attempt was made, however, to follow the moon's motion, so the pictured disk could hardly have exhibited the circular

outline of the object it portrayed (*Comptes rendus*, vol. xxx. p. 710, 1850).

After the discovery of the collodion process by Scott Archer in 1851, lunar photography grew apace. Warren De La Rue exhibited some photographs of the moon at the Royal Astronomical Society in 1853. With respect to these pictures he afterwards remarked: "At the latter end of 1852 I made some very successful positive lunar photographs in from two to thirty seconds on a collodion film, by means of an equatorially mounted reflecting telescope of 13 inches aperture, and 10 feet focal length, made in my workshop, the optical portion with my own hands, and I believe I was the first to use the then recently discovered collodion in celestial photography." No automatic driving motion was attached to the telescope, and the moon's motions both in right ascension and declination were followed by adjusting a sliding frame attached to the eyepiece holder, in the diagonal parallel with the moon's apparent path (Brit. Assoc. Rep., Aberdeen, 1859, p. 131).

In July 1853, Prof. J. Phillips obtained photographs of the moon 1¼ inch in diameter on a collodion plate exposed for five minutes in the first focus of a 6¼-inch refractor. Some of the pictures were exhibited at the Hull meeting of the British Association in September 1853, on which occasion Prof. Phillips read a paper "On Photographs of the Moon," and pointed out the many advantages to be gained by the development of lunar photography (Brit. Assoc. Rep., Hull, 1853, p. 14). He also dwelt on the desirability of using reflecting telescopes for the purpose because of the fact that in such instruments the chemical and optical foci coincide.

The Rev. J. B. Reade, the discoverer of many important improvements in photographic processes, made several not very successful attempts to obtain daguerreotypes, whilst Bond and Whipple were producing such pictures in America. Later, in 1854, by exposing a collodion plate for thirty-five seconds in the focus of a reflector having an aperture of 24 inches, a negative of the full moon was obtained from which enlargements 9 inches in diameter were made. These results were exhibited at the meeting of the British Association held at Liverpool in 1854 (British Association Report, 1854, p. 10).

Mr. Hartnup, of the Liverpool Observatory, in conjunction with Dr. Edwards and Mr. Forrest, also took some lunar photographs in 1854, by means of an 8-inch refractor, and exhibited the results at the above meeting (*ibid.*, p. 66).

Prof. Crookes began work with the same instrument in 1854, and his first step towards obtaining good negatives was the introduction of the purest chemicals. This, and a strict adherence to correct formulæ, enabled him to reduce the exposure from thirty to four seconds. The diameter of the moon's image in the first focus of the instrument used was 1·35 inch, and the negatives obtained bore an enlargement of twenty times, but on account of the proportional magnification of defects in the film, the results were not perfect. To eliminate defects arising from this cause, Prof. Crookes suggested that "The magnifying must be conducted simultaneously with the photographing, either by having the eyepiece on the telescope, or, better still, by having a proper arrangement of lenses to throw a magnified moon image at once on the collodion" (Roy. Soc. Proc., vol. viii. p. 363, 1857).

In 1857, Mr. S. Fry obtained photographs of the full moon by means of an eight and a half inch refractor. With this instrument it was found that the average exposure for the full moon was three seconds, for half moon twelve seconds, and for quarter moon forty-five seconds; collodion plates being used. Mr. Fry observed that the distance of the chemical focus from the object-glass was subject to variation, the change being most probably due to variations in temperature (*Photographic Journal*, vii. p. 80, 1862).

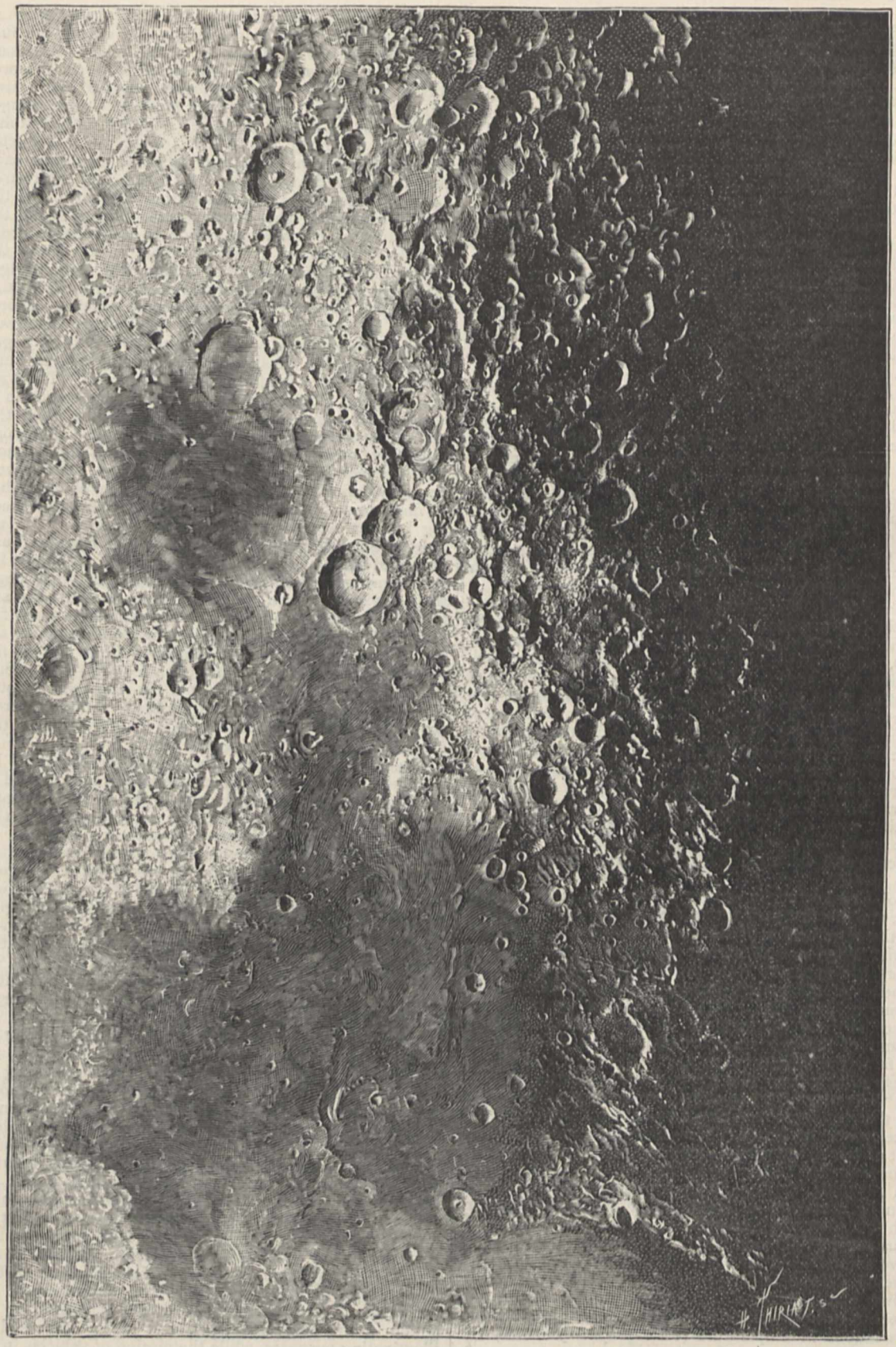
Secchi paid much attention to the photography of particular portions of our satellite, and during the first quarter. The chemical activity of the light of the moon at full and at first quarter was found to be in the proportion of three to one (*Comptes rendus*, vols. xlii., xlvi., 1856, 1858). In 1857, Sir Howard Grubb, using a refractor of 12 inches aperture, obtained photographic images of the moon a little over two inches in diameter with exposures from ten to forty seconds. A sliding back similar to that invented by De La Rue and afterwards improved upon by Lord Rosse, was used to follow the moon's motion. The improvement consisted in the application of clock-work motion to the slide in order to follow motion in declination and in regulating the driving clock of the equatorial to follow the moon in right ascension (Dublin Photographic Society, May 6, 1857.)

Although De La Rue obtained some excellent photographs in 1852, when working under very disadvantageous conditions, it was not until 1857 that he began to produce those detailed representations of the lunar surface that have made his name immortal. The want of a driving clock was the cause of the cessation of lunar photography in the former year, and when this had been supplied, De La Rue continued his work. Numerous positives on glass and negatives slightly more than an inch in diameter were obtained. These were perfectly defined and bore a magnification of more than 16 diameters. In 1859, at the British Association meeting held at Aberdeen, De La Rue reported "On the Present State of Celestial Photography in England," and exhibited some of the fruits of his labour. Amongst the specimens were positive enlarged copies of other negatives, eight inches in diameter, which would bear still further enlargement, and instantaneous pictures of the full moon. It was noted that very strong pictures of the full moon were produced with exposures from one to five seconds, and that the crescent moon required from twenty to thirty seconds. A great part of the report was devoted to a discussion of the methods adopted in taking stereoscopic pictures of the moon, many photographs of this character being exhibited at the meeting.

The extensive multiplication of enlarged copies of De La Rue's negatives renders it unnecessary to expatiate on their excellency. A magnificent series of twelve photos was published in book form, and also enlarged so that the lunar disk had a diameter of seventeen inches. In this series the moon's progress was traced from the time when she was six days old through the waxing and waning periods to the 23½ day. Each of the pictures was a work of art, whilst the many details they contained gave them a high scientific value, and conclusively demonstrated the applicability of photography to the delineation of celestial bodies.

An enlargement three feet in diameter, from a negative taken by De La Rue in 1858 is suspended in the library of the Royal Astronomical Society.

Rutherford began his work in lunar photography in 1858 with a refractor having a focal length of fourteen feet, and an aperture of eleven and a quarter inches. By reducing the aperture of the telescope to five inches for the full moon, negatives were produced which would bear enlargement to fifty diameters, or five inches. In the same year, whilst De La Rue was obtaining stereoscopic pictures in England, Rutherford was working in the same direction in America, and with similar results. To the general public the photographs taken by Rutherford in 1858 left little to be desired, but they did not reach that degree of perfection which is necessary to satisfy a scientifically cultured mind. A mirror having a diameter of thirteen inches was therefore worked and fixed on the tube of the refractor in 1861. The results obtained were, however, still deemed unsatisfactory. The mirror soon became tarnished by the action of the combustion products of the gas used for illuminating purposes, while the motion of vehicles in the



Central Region of the Moon. (From a Photograph by the Brothers Henry.)

neighbouring street gave it vibrations, which by reflection were doubled in amount. The reflector was therefore abandoned, and Rutherford resolved to have an object-glass made of the same size as that formerly used by him, but specially corrected for photographic rays. With the completion of this instrument Rutherford's best results began. In March 1866, some remarkably fine negatives were obtained with exposures from two to three seconds three days after the first quarter, and one-quarter of a second for the full moon. The publication of enlargements from these negatives, having a diameter of twenty-one inches, was much appreciated by astronomers and others interested in lunar photography.

No man has done more in the furtherance of celestial photography than Dr. Henry Draper, the son of the renowned physicist to whom reference has already been made. After a brilliant scholastic career he was associated with his father in many important researches. A journey to the British Isles in 1857 gave Dr. Draper the opportunity of visiting Lord Rosse's observatory at Parsonstown. He was so struck with the power of the great reflecting telescope, that on returning to America in 1858 he began the working of a similar speculum having a diameter of 15 inches. This was afterwards discarded, and a silvered glass Newtonian reflector, having a diameter of 15½ inches, was constructed, and adapted for celestial photography. Detailed descriptions of the construction and testing of the mirror, the method of silvering, and the manner in which it is mounted, are embodied in a memoir by Dr. Draper "On the construction and use of a silvered glass telescope, 15½ inches in aperture, and its use in celestial photography" ("Smithsonian Contributions to Knowledge," vol. xiv. p. 52, 1864). Instead of driving the telescope in the usual way by means of a clock, Dr. Draper used a sliding plate holder, driven by a "clepsydra" specially devised for the purpose. Some perfectly defined negatives were obtained in 1863, about 1½ inches in diameter; many of them were enlarged to 2 feet, and from one a magnificent picture was made in which the lunar disc had a diameter of 50 inches. The beauty of the copies was probably due to some extent to the fact that a concave mirror was used instead of a combination of lenses in the process of enlarging.

From the time when Dr. Henry Draper produced his best results until last year very little remarkable work had been done in lunar photography. In 1866, Mr. A. Brothers took several good negatives $\frac{11}{16}$ of an inch in diameter in the first focus of a 5-inch refractor, and by the insertion of a Barlow lens he increased the size of the image to 1¼ inches. Enlargements from these negatives were distributed to many astronomers, and evidence of their excellency is afforded by the circumstance that they were mistaken for some of Rutherford's productions by the editor of a scientific journal, and commented upon as such. Mr. Brothers gave a long account of the development of celestial photography in the paper in which his method of work was described (Proceedings of the Literary and Philosophical Society of Manchester, vol. v. p. 68, 1865–66.)

In 1872, Mr. Ellery, the Director of Melbourne Observatory, presented some remarkably sharp lunar photographs to the Royal Astronomical Society, that he had obtained by means of the great reflector (*Monthly Notices R.A.S.*, vol. xxxiii. p. 219, 1873.)

Amongst other lunar photographs possessed by the Royal Astronomical Society are two taken by Dr. Gould at Cordoba Observatory in 1875–76, in each of which the moon has a diameter of nearly 20 inches. A photograph taken in 1877 by Prof. Pritchard at Oxford, with the reflector used by De La Rue, and some taken in 1880 by Mr. Common with his three-foot reflector, also figure in the above collection as remarkable works of art having an important scientific signification.

In a recently published paper on "Astronomical Photography at the Lick Observatory" ("Publications of the Astronomical Society of the Pacific," vol. ii., No. 9), Prof. Holden gives a detailed account of the photographic apparatus of the great equatorial, and the work done with it. The image of the moon in the first focus of this instrument is nearly five and a quarter inches in diameter, and the negatives bear easily an enlargement of 570 diameters, and even double this amount. In the production of these negatives the aperture of the object-glass was reduced to 12 inches. From an examination of the best pictures yet taken at the Lick Observatory, Prof. Holden finds that parallel walls on the moon whose tops are no more than 200 yards or so in width, and which are not more than 1000 or 1200 yards apart, are plainly visible. A series of copies from the negatives obtained at Lick Observatory has been published.

Some photographs of the moon taken in March last, by the Brothers Henry, at Paris Observatory, appear to eclipse all previous ones. The instrument used was the 13-inch photographic equatorial, and an examination of the plate which accompanies this note will show that real progress has been made. The superiority of the results is due not only to the perfection of the object-glass, but to the use of a secondary magnifier, by means of which the size of the image at the first focus was increased fifteen times. It is manifest that this method of direct enlargement possesses many advantages over that ordinarily used, and its further development will be awaited with considerable interest.

There is no doubt that enlarged photographs of our satellite are capable of affording more information regarding its surface than can be gained by years of diligent observation, whilst their multiplication at different epochs will enable selenographers to readily detect changes of a comparatively minute character. The study of the lunar surface has always excited interest. Hence the contribution to knowledge afforded by the photographs taken by MM. Paul and Prosper Henry will not lack the appreciation it fully deserves.

RICHARD A. GREGORY.

COMPARATIVE PALATABILITY OF INSECTS, &c.

IN the course of last autumn and the present summer we made a series of experiments bearing upon the relative palatability of insects, &c.,; the animals chiefly experimented on being domestic mice, common toads, and a common Mynah (*Acridotheres tristis*). We obtained the following results.

Among beetles, *Carabus violaceus*, which emits a very strong, unpleasant-smelling fluid, was once eaten by the toads, and twice by the mice. As a rule, however, it seemed too large and strong for either. The Mynah, also, was not very fond of it.

Torostichus niger, and the nearly-allied red-legged species, which also emit strong-smelling fluid, were readily taken by all the animals under observation: though they sometimes caused the mice a little trouble.

The small copper-coloured ground-beetles were eaten readily by the Mynah and toads, but in every case refused by the mice.

Melolontha vulgaris was liked by the mice and toads. We did not offer it to the Mynah.

Coccinella bipunctata was invariably licked and refused by the mice, even when hungry. The toads took it readily. We did not offer it to the Mynah.

Ocypus olens, the "devil's coach horse," was taken without hesitation by the toads, even in its defiant attitude, with the head and abdomen erected. On one or two occasions, however, it was immediately ejected. This has also happened with *Torostichus niger*, and appears

to be due to the bite of the insect rather than to the emission by it of unpleasant matter. The *Ocypus* was eaten by the Mynah.

The red soldier-beetle was seized by one mouse, which, however, left the abdomen. It was refused by another, which was feeding rather poorly at the time; though the same animal, immediately afterwards, killed and partly ate a house-fly. This beetle was eaten by the toads. We did not offer it to the Mynah.

The dung-beetle (*Geotropes stercorarius*) was offered only to the toads. It was apparently too large and strong for them.

Among Hymenoptera, only one *Bombus* (*terrestris*) was offered to the mice: they seemed afraid to touch it. We were surprised at this, in the face of Darwin's fact of field-mice attacking nests of Bombi. The Mynah ate wasps greedily. The toads readily took wasps and bees (*Megachile*, *Apis*, *Bombus*), only occasionally refusing the large queens of the Bombi. They were often stung, but did not seem to suffer from this, since they would take three or four of the insects in succession.

We were not fortunate enough this year to take any of the Chrysididæ. Experiments should certainly be made with these.

Of Lepidoptera, the Mynah was offered *Pieris rapæ* and *Vanessa urticæ*. It would eat both; but greatly preferred the latter. We gave the mice *Pierides rabæ* and *napi*, *Vanessa urticæ*, *Tryphæna pronuba*, some other (dull-coloured) *Noctuæ*, and some *Geometræ*. All were eaten. *Pieris rapæ*, *Vanessa urticæ*, *Bryophila perla*, *Plusia gamma*, and several other (dull-coloured) moths, were offered to the toads. Two specimens of the *Bryophila* were eaten; but the other insects were almost invariably unregarded. This appeared to us to require explanation, as the other animals ate butterflies and moths so readily. We kept our toads in an open enclosure; and were therefore obliged to mutilate the wings of the insects given them. The consequence was that these either fluttered violently or remained perfectly stationary; and toads do not seem to take food under either of these conditions.

The silkworm moth was taken by the mice; to which alone we offered it.

The swallow-tail moth (*Urapteryx sambucaria*), of which we only obtained one specimen, was eaten by a mouse.

Green and brown larvæ were taken greedily by the Mynah and toads. The latter also ate the bright-coloured caterpillars of *Pieris* sp. (*rapæ?*), and any hairy caterpillars that were offered them. Among them was that of *Orgyia antiqua*. In one case a hairy caterpillar was not swallowed till two or three attempts had been made to secure it. No hairy caterpillars were offered to the other animals.

Some bright orange-coloured larvæ, with black heads—found feeding, in a web, on hawthorn—were readily eaten by the toads and by one mouse. Another mouse (feeding poorly) refused them.

A scarlet-and-black bug was eaten by the toads; as also was the lace-wing fly (*Chrysopa perla*). Neither insect was offered to the other animals.

Three sword-tailed grasshoppers were readily eaten by a mouse.

Blatta orientalis was eaten by the toads. We did not give it to the mice. The Mynah for a long time refused it, and only took it finally in the dearth of other insects. The same holds good, in its case, of *Lumbricus terrestris*.

A few centipedes were given to the mice and the Mynah. These were never eaten; though the mice, in one case, eagerly seized and killed a large specimen. We offered small frogs to the Mynah, which seized, but did not eat them; leaving them apparently unhurt. The toads eat —though with some difficulty—small newts; which a water tortoise (*Emys* sp.) will not take.

E. B. TITCHENER.
F. FINN.

A young heron (*Ardea cinerea*), which takes frogs freely, killed, but did not eat, a common toad.

A water-tortoise (*Emys* sp.), though it eats small frogs, will not touch a toad. E. B. TITCHENER.

Zeuzera æsculi was offered to a prairie owl at the Zoological Gardens; and though eagerly seized, left alive after considerable examination. Queen ants were taken by toads and by the common lizard (*Lacerta vivipara*).

F. FINN.

THE PROGRESS OF BIOLOGY IN CANADA.

WE have before us the official account of the formal opening of the new building of the Biological Department of the University of Toronto, on December 19 last. The building is a substantial stone one in Scottish Norman style, replete with the most modern fittings and accessories; and the lecture hall, which may be approached independently of the main edifice, is benched to seat a minimum audience of 250. The work of the institution is presided over by Prof. R. Ramsay Wright. The classes in biology are said to be among the largest in the University, and the excellence of the new arrangements and teaching appliances elicited, at the opening ceremony (from Prof. Osler, an old student of the parent college), the remark that "it is possible for one to live through a renaissance, similar perhaps in kind, less important in degree, than that" directed against mediæval thought. May this be justified! Certain it is that the biological work now in progress in Toronto was begun under most auspicious circumstances.

Prof. Ramsay Wright is well-known and respected in this country and, at the opening of his new building, allegiance was sworn him by Minot and other biologists of the New World whose published researches, like his own, rank high in contemporary literature. Investigations like those upon the spiracular cleft of Ganoids, the nervous system of the tadpole's epiderma and of the liver, which his school has given to the world, are not to be easily matched as thoroughgoing and honest pieces of work. They denote a high standard of attainment, and one which, in face of the inanities of certain trans-Atlantic workers of another type, must be maintained if the biological brotherhood of the New World is to hold its own.

The Biological Department of the University of Toronto exists in connection with a Medical School, and it is therefore not surprising to find signs of a leaning towards bacteriology and those allied branches of study which, as being furthered by Mentschnikoff and his pupils, by Darier, Podwyssozki, Neisser, Ruffer, Macallum, and others, are just now assuming a revolutionary phase. Indeed, the key-note was struck by Prof. Wright in the peroration to his opening address, in which he said that "not only bacteria, but low forms of animal life furnish important pathogenic organisms." We rejoice in this the more, now that an outcry against the biological training of the surgeon-student is being raised at home, by persons who clamour for the restoration of an apprenticeship system. From the utterances of distinguished medical experts made at the Toronto ceremony, it is certain that this proposal will meet with no response from the New World.

The Biological Institute of Toronto is detached from the main University building. The latter was, on February 14 last, almost wholly destroyed by fire. During the preparations for the annual *conversazione*, a wooden

tray covered with lighted lamps fell to pieces, while being carried; a lamp was upset, and, although the burning mass was heroically carried towards the exterior by the Sub-Curator and a caretaker, the building, its valuable contents, museums, and books, were for the most part destroyed. Prof. Wright has been for some months on a tour of inspection in Europe, seeking, among other things, gifts of specimens and books. Truly, our Canadian brethren do not deserve these unless better able to take care of them than in the past. Prof. Wright assures us that such will be the case, and, on his behalf, we appeal to specialists and others who may be possessed of duplicates, and to those who may be otherwise willing, to help. The position is one which threatens to injure seriously the educational prospects of a rapidly advancing country to which we, at home, are much beholden; and it calls for combined action, by which alone a loss such as that we deplore can be made good.

NOTES.

AT a meeting of the Royal Geographical Society of Australasia, held at Melbourne on August 22, a letter from Sir Thomas Elder was read, in which he offered to bear the entire cost of an expedition to the unexplored regions of Australia. A report on the question of Antarctic exploration was also submitted to the meeting. In this report it was stated that public interest in the subject had been revived by the announcement that Baron A. E. Nordenskiöld, after a conference with his friend, Baron Oscar Dickson, had consented to take the command of an expedition to the South Polar regions, on the condition that the Australian colonies contributed a sum of £5000 towards the expenses, Baron Dickson having offered to advance the other moiety, or whatever more might be necessary. "The offers were cordially accepted, and the Antarctic Committee felt itself justified in making the necessary arrangements without delay for collecting the amount to be contributed by the Australasian colonies. The Council of the Society had passed resolutions recognizing a national duty in the exploration of the Antarctic regions, especially that portion lying opposite to Australasia, pledging itself to use its influence in promoting the enterprise, and giving authority to head a subscription list in aid of the Swedish-Australian Exploration Fund with a donation of £200 from the Society's funds. It would appear from the hearty reception accorded to the proposals of the Antarctic Committee that the latter might rely upon the energetic co-operation of all the scientific societies of Australasia, and thus be enabled to collect the amount of the contribution promised towards defraying the expenses of the combined Swedish and Australian Exploring Expedition to the South Polar Regions." The report on being put to the meeting was "received with acclamation."

AN expedition to Greenland will start from Denmark next year, under the command of Lieutenant Ryder, to investigate the east coast between lat. 66° and 73°.

PROF. EDWARD HULL, F.R.S., has severed his connection with the Geological Survey of Ireland, of which he has been Director for nearly 21 years. The one-inch geological survey of Ireland having been completed, the staff has been reduced. The Dublin *Daily Express*, commenting on Prof. Hull's retirement, says he takes with him "the best wishes of his colleagues, who will retain a vivid recollection of the consideration, kindness, and sympathy which he ever manifested towards them."

THE India Store Department lately sent to the Royal Gardens, Kew, specimens of oak-staves which had formed part of a beer-barrel. The barrel was made in the early part of 1889, filled with malt liquor in the autumn, and shipped with others as Government stores in March 1890 to Calcutta. The contents were spoiled, and the authorities at Calcutta reported that some casks were found to have been attacked by wire-worm or borer. Were the casks unsound when shipped from this country, or had they been attacked on board ship during the voyage out? The matter was submitted to Mr. W. F. H. Blandford, Lecturer on Entomology at the Indian Civil Engineering College, Cooper's Hill; and his report, which embodies the results of much ingenious labour, is published in the new number of the *Kew Bulletin*. "Notwithstanding the somewhat scanty material that was available," says the *Bulletin*, "Mr. Blandford has very skilfully traced the cause of the injury, and probably also identified the particular insect concerned. Further, he has shown that the injury to the wood had occurred before it was worked up into barrels, although, owing to the very minute holes made by the insects, it was almost impossible to detect their presence." Other subjects dealt with in this number of the *Bulletin* are: prickly pear in South Africa, Jarrah timber, treatment of mildew on vines, cultural industries in West Africa, and economic plants of Madagascar.

MR. CECIL CARUS-WILSON writes to us that he has recently invented a luminous crayon for the purpose of enabling lecturers to draw on the blackboard when the room is darkened for the use of the lantern. He hopes that the invention may prove of value not only to lecturers who use a lantern, but also (in another form) to those students who wish to take notes.

MR. ROBERT SWORDY, of Dryburn Cottage, Durham, sends us a letter which has been printed in the *Durham County Advertiser*, giving an account of a toad (*Bufo vulgaris*) which he recently saw crawling out of the Pond Wood at Aykleyheads. The muscles of the toad's body were (as usual) arranged in such a fashion that the back of the toad looked like minute nodules of dark gravel embedded in a damp path below trees; but what seemed to Mr. Swordy most remarkable was that on the top of this gravel-like arrangement of muscles there was spread a mesh or network of very fine lichen, with oval-shaped leaves of a lightish green colour, connected more or less to each other by a hair-like process of stems. This lichen spread irregularly over the toad's back, and odd sprays of it were also to be seen on the legs and upper surfaces of the feet. "Now," says the writer, "had the toad been in its regular haunts under the trees and shrubs, with this wonderful counterfeit of gravel and protective colouring, it would have been almost impossible to discriminate its form from the dark gravel, lichens, moss, wood-sorrel, and dead leaves of the place, and I doubt not that this animal's unobtrusive attire would aid it materially in capturing the insects necessary for its sustenance." Mr. Swordy encloses photographs of the toad sitting on a section of lichen-coloured gravel path, taken from near the spot where he found it.

MESSRS. THOS. J. SYER AND CO. inform us that they have, at 45 Wilson Street, Finsbury Square, London, a class-room in which are taught, practically, various trades, such as carpentry, cabinet-work, wood-carving, &c. The winter session is said to have been very successfully opened, and Mr. Syer, who acts as principal, invites anyone who may be interested in the subject to visit the room, and see the work in progress.

A WORK on art among the Dayaks of Borneo, by Alois Raimund Hein, has been issued at Vienna. The publisher is Alfred Hölder.

MR. WILLIAM P. COLLINS, scientific bookseller, has issued a Catalogue (No. 24) of miscellaneous scientific books.

THE next meeting of the Royal Microscopical Society will be held on Wednesday, the 15th inst., at 8 o'clock, when the following papers will be read:—Note on a new type of Foraminifer, by H. B. Brady; new method of demonstrating intercellular protoplasmic continuity, by P. C. Waite; and, simple form of warm stage for the microscope, by F. Dowdeswell.

THERE is some difference of opinion as to the original meaning of the word "kangaroo." At the meeting of the Linnean Society of New South Wales on August 27, the question was discussed whether, in the dialect of the blacks of the Endeavour River, the word signified "I don't know," and was so used in answer to the queries of Captain Cook's party, or whether, as Cook supposed, it really was the name of the animal in use among the aborigines of the locality.

AT the same meeting Mr. A. J. North criticized the statement of the late Mr. Gould that the gay attire of the members of the genus *Malurus* "is only assumed during the pairing season, and is retained for a very short period, after which the sexes are alike in colouring" ("Hand-book to the Birds of Australia," i. 317). According to Mr. North, full-plumaged males, more particularly in the section of the genus in which blue predominates, are to be met with all the year round.

A VALUABLE contribution to the subject of atmospheric electricity has been lately made by Prof. L. Weber, who, in experiments at Breslau, used a sensitive, earth-connected galvanometer, instead of the electroscope in Exner's method. Using Exner's metallic rod and flame, he found that the currents were extremely small, about a micromilliampere (or the thousand-millionth part of an ampere). They were increased with a longer rod and bigger flame; but much better results were got with a kite or captive balloon. The edge of the kite was coated with silver paper, and the tail was formed with tassels of the paper. A line of fine steel wire was used, and about 12 feet at the upper end were of non-conducting string. Experiments were made on 12 cloudless days. Taking the intensities of current as ordinates, and the heights to which the kite (or balloon) rose as abscissæ, the curve of intensity had its convex side to the axis of abscissæ. On but few days was the current negative, this effect being probably due (the author thinks) to dust charged with negative electricity which it gave to the line. This might neutralize some of the positive electricity set flowing in the wire by the earth's induction. Prof. Weber considers that any experiments on the earth's surface with short conductors can at best give relative values and determine periodical changes. His values differ not inconsiderably from Exner's. At a height of 350 m. (1166 feet) the potential was found to be 96,400 volts; and, assuming a regular increase of potential with height, the fall of potential would here be 275 volts. The potential of the earth is estimated at the enormous value of $1720 \cdot 10^6$ volts. Supposing the volt to be about the electromotive force of a Daniell element, a huge battery of this number of elements would be needed to produce the earth's potential, the zinc pole being connected with earth, and the copper led into space. Prof. Weber considers the question of possible electric repulsion from the earth, and is led to some instructive remarks on rain particles, clouds, &c. Some very interesting effects were obtained from thunder-clouds; but for these and other matters we may refer to the original (an account of these researches appears in *Humboldt* for September).

THE Smithsonian Institution is publishing some interesting reports of the results of explorations by the U.S. Fish Commission steamer *Albatross*. In one of these reports Mr. Charles H. Townsend deals with birds from the coasts of western North America, and adjacent islands. Mr. Townsend, referring to several of the islands visited by the *Albatross*, points out that a rich field awaits the naturalist who may explore them. "The islands of the Santa Barbara group," he says, "have hitherto been very imperfectly explored with regard to their fauna. Clarion and San Benedicte Islands, of the Revillagigedo group, had never before been visited by naturalists. Socorro, an island of the same group, and one abounding in peculiar species of vertebrates, had not been visited since the type specimens were collected by Grayson, about the year 1870. The flora of all the Revillagigedo Islands is practically unknown, as the *Albatross* brought back only a small collection of flowering plants."

THE Royal Meteorological Society have published the first part of vol. x. of the *Meteorological Record*, containing the results of observations for the quarter ending March 31 last, with remarks on the weather by W. Marriott, Assistant Secretary, containing a large amount of useful information, compressed into 20 pages. The remarks show at a glance whether temperature, rainfall, &c., have been above or below the average; for the period in question the temperature of January was, on the whole, very mild, while cold spells occurred from February 3–15, and from February 20 till March 5. During the first few days of March, temperatures were lower than in any other March for nearly 50 years; but, on the whole, the temperature of the quarter, and also the rainfall, were above the average. The tables contain the values of bright sunshine for 31 stations; monthly results of observations at stations of the second order (for 9 a.m. and 9 p.m.) at 25 stations; abstracts of climatological observations, chiefly temperature and rainfall (for 9 a.m.) at 73 stations; earth temperatures observed between 3 inches and 6 feet at various stations; and, lastly, the observations from the Quarterly Reports of the Registrar-General, with remarks on the weather by James Glaisher.

THE second part of the Annual Report of the Chief Signal Officer (U.S.) for 1889 contains a treatise entitled, "Preparatory Studies for Deductive Methods in Storm and Weather Predictions," by Prof. Cleveland Abbe. The object of the paper is to consider the physical principles that are involved in the formation and motion of storms, and that have guided the author in predicting storms in his official capacity in the Signal Service, and it is an able and most instructive exposition, with very few mathematical formulæ, of the progress made in meteorological science during the last thirty years. The author distinguishes between matters that are important, such as the earth's rotation, gravitation, and solar radiation, and those that are unimportant, such as lunar influence, atmospheric electricity, and magnetic disturbances. The general idea that underlies the work is that a storm centre moves towards the region where conditions produce the greatest precipitation of aqueous vapour. Objection is urged against the idea that high westerly currents carry the storms of America eastward. The work is obtainable in a separate form.

A NEW theory of sea-sickness has been recently offered by M. Rochet. Accepting the view that the symptoms are those of cerebral anæmia, he accounts for this anæmia by the disorder brought into muscular contractions through not being used to such sudden movements as those of vessels. He points out the enormous capacity of the reservoir formed by the muscular and perimuscular venous system, and the considerable *rôle* of tonicity and voluntary or reflex muscular contractions in the action of emptying it; also the predominance of reflex muscular actions over voluntary, in keeping one's balance, and in most movements. In the movements of a vessel, the relaxation of muscular tonicity and suppression of reflex movements result in a considerable increase of the peripheric reservoir, and, as a consequence, in cerebral anæmia. Hence it is that the descent of the ship is the most trying motion; and one can understand the benefit of the horizontal position, compression of the abdomen, fixing the body in a tight position, &c. Very young children are not ill, because the education of the reflexes in them is not yet accomplished. On solid ground they reel as on deck. M. Rochet's advice is, not to look to anæsthetics, soothing drugs, &c., for relief, but rather to muscular excitants, and above all to seek in voluntary movements a compensation for the reflex

movements which are not produced. He recommends strychnine, veratrine, ergot of rye, and drinks charged with carbonic acid.

MR. S. V. PROUDFIT has presented to the U.S. National Museum a collection of stone implements from the district of Columbia. In an account of the collection, published in the Proceedings of the Museum, Mr. Proudfit pays a tribute to the handicraft of the aboriginal tribes of the region in which the collection has been formed. The material with which they wrought was, he says, the most obdurate and refractory of all substances found available to any considerable degree among the American Indians. Quartz, quartzite, and argillite for the greater part were used from necessity, no better material being within reach. The first two are very hard, and, in the hand of the workman, full of unpleasant surprises. The argillite, though softer, is not susceptible of receiving or retaining any high degree of finish. Notwithstanding these obstacles, the material was treated "with such patience, care, and skill, that the work of this region, not only in matters of utility, but in points of finish, compares favourably with that of any other."

A PAMPHLET by Dr. Edward Sang, on the exhibition of curves produced by the vibration of straight wires, which was read before the Scottish Society of Arts last November, has been sent to us. The means adopted for obtaining these curves was to make one end of a wire fast in a vice, while the other end was free to move; the motion of the wire being made visible by fixing to the free end a small polished knob capable of reflecting light from some given source. These phenomena were clearly found to be connected with the unroundness of the wires, and the object of the paper was to inquire what would be the result with a given irregularity. The ratios of vibrations having been varied, different results were obtained, and it was noted that when the ratio was expressed by two odd numbers, the closed curve connected two opposite corners and passed through the centre, but that when one of the numbers was even, the closed curve connected two adjacent corners and did not pass through the point of rest. Illustrations of some of these curves are given, showing their delicacy and symmetry similar to those curves formed by the resultant motion of two pendulums of different periods oscillating at right angles to one another. With bent wires particularly, as the author states, "the poetry of motion, the gracefulness of curvature, attract the student of the fine arts, who may find examples ranging from the severe classic and tragic to the extravagant burlesque styles."

IN the last issue of the *Bulletin* of the Moscow Naturalist, Madame Marie Pavloff concludes her excellent studies on the palæontology of the Ungulata. She examines the fossil relics of the *Hipparion* in Russia (*H. mediterraneum* and *H. gracile* which she considers as the same species, and the probably new species of *H. minus*), as well as the relics of the Pleistocene horses found in Russia, and gives a genealogy of the Equideæ since the Mio-Pliocene period. At the beginning of the Middle Pliocene, horses akin to *Eq. hippidium*, which at that time were living in America only, emigrated from West America to Asia, and during the Middle Pliocene epoch they developed in the Siwalik mountains into forms now described under the name of *Equus sivalensis*. Part of the latter migrated from Asia to Africa, at that time connected with Italy, and thus reached Europe. In the Upper Pliocene deposits of Africa and Europe we have the *Eq. stenonis*, which is very near to the foregoing. Having thus reached Europe from Asia during the Upper Pliocene, they left their fossil relics in the *Eq. stenonis* in Italy, Austria, Germany, France, Great Britain, and Russia, and slowly evolved the Pleistocene species of *Equus caballus*. However, one part only of the *Equus sivalensis* having left Asia, the remainder developed at the same time into the *Equus nomadicus* in Asia; while in America a parallel evolution gave rise to the *Eq. excellus* and *Eq. major* and to *Equus caballus fossilis* in Africa. As to the present horses of Russia, they all originated from the same Pleistocene species which already at that time offered great varieties in Europe. The variety of the Russian races depends upon the continued mixture of forms which developed in Russia with those which were imported from Asia on the one side, and from Western Europe on the other side.

SIR WILLIAM GREGORY, a former Governor of Ceylon, has lately been revisiting that island, and has communicated to a local journal a series of notes and observations. In one of these he refers to the well-known Colombo Museum, as to which he says it is hoped that a very liberal extension will be conceded by the Legislative Council without delay. Important objects of natural history have been procured and cannot yet be exhibited, books of value to the general reader and to inquirers have accumulated without the means of arrangement, and the space for large archæological objects which should be carefully and liberally displayed is altogether defective. There is one department, continues Sir William, hitherto much neglected, to which special care should hereafter be devoted, viz. that of geology. A geologist of high attainments ought to be engaged for a fixed period of a few years, during which a general geological survey should be made and a perfect collection be formed of the rocks, clays, and gems which are a specialty of Ceylon. These, if properly exhibited and properly protected from theft, would be one of the most valuable and interesting portions of the Museum to a large number of visitors.

THE *North China Herald* of Shanghai, in a recent curious and interesting article on modern science in China, says that the views now held by intelligent Chinese on the origin of science are that the knowledge possessed by their ancestors leaked out to the men of Western nations, who improved on the information they received, and gradually developed modern sciences and inventions. This idea was started by Mei Wu-ngan in the reign of Kanghi, and has been maintained ever since with singular persistence, and the cultivated class have consoled themselves with this thought during the past two centuries. Those who are really in favour of introducing foreign improvements say:—"We wish to make use of the knowledge of Western men because we know that what they have attained in science and invention has been through the help that our sages gave them. We have a good right to it. What Europe has done she has done through the help we gave. If we did not exactly give science to Europe, we gave it the fruitful germ which produced it. They have the science of optics, but in our 'Motsz' we find that reflection from mirrors was known in the days of Mencius. The men of the West hold that the earth is round. This was believed also by our poet Chü Yuen, who in his ode on astronomy announces this doctrine; and this was not many years after Mencius. This being so, we ought not to be ashamed of the study of Western science. We are the rivals of the Western kingdoms, and it is good policy to use their spears in order to pierce their shields. We ought to train our youth in Western science so that we may know how best to meet them in the struggle to resist their encroachments." Mei Wu-ngan and others read the books translated by the Jesuits, including Euclid and the teaching of astronomy, and they were delighted with the new views. The Jesuits, however, were in high favour at Court, and while they basked in sunshine the native mathematicians shivered in the shade. This was not agreeable, and the native astronomers went home each day from Court dissatisfied. One of them, Yang, ventured to foretell an eclipse. Adam Schaal, a Jesuit, in Pekin, foretold the same eclipse, and his hours, minutes, and seconds agreed with the fact. This was a crucial case. All Pekin was waiting with interest to know the result. The pro-

phecy of the foreigner proved by its fulfilment the errors of the Chinese mathematician, who retired in disgrace from the position which he held. He went back to his home to write the book called "The Inevitable Exposure," which contained a series of calumnies and grossly untrue accusations against the Jesuit fathers. This bad book made him much more notorious than his works on mathematics. The unscrupulous enemies of the Westerns have reprinted it again and again, and they still do so. Very different was the tone of Mei Wu-ngan, who was invited three days in succession by the Emperor Kanghi to converse with him upon mathematical subjects. He had a fondness for mathematics, and read voraciously. He was therefore in a position to criticize Western knowledge in an appreciative manner.

THE additions to the Zoological Society's Gardens during the past week include two Grizzly Bears (*Ursus horribilis*) from the Missouri Brakes, Montana, U.S.A., presented by Mr. Ewen Somerlid Cameron; a Raccoon (*Procyon lotor*) from the Catskill Mountains, New York State, presented by Mr. James H. Frodsham; a Greater Black-backed Gull (*Larus marinus*), a Herring Gull (*Larus argentatus*), British, presented by Mr. A M. Bailey; a Common Tern (*Sterna hirundo*), British, presented by Mr. A. C. Howard; two Mississippi Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Miss Edith Baker; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, a Great Kangaroo (*Macropus giganteus* ♂) from Australia, deposited; a Horned Screamer (*Palamedea cornuta*) from the Amazons, three Violet Tanagers (*Euphonia violacea*) from Brazil, an Ocellated Sand Skink (*Seps ocellata*), South European, purchased; a Chestnut-breasted Duck (*Anas castanea*) from Australia, received in exchange; a Crested Pigeon (*Ocyphaps lophotes*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on October 9 = 23h. 13m. 52s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 4892	—	—	22 59 26	+11 44
(2) G.C. 4921	—	—	23 10 22	+ 5 46
(3) χ Aquarii...	5	Yellowish-red.	23 11 9	− 8 13
(4) ξ Pegasi	5	Yellowish-white.	22 40 26	+11 40
(5) 19 Piscium	6	Red.	23 40 46	+ 2 52
(6) R Aquilæ	Var.	Very red.	19 1 5	+ 8 4

Remarks.

(1 and 2) Neither of these nebulæ have yet had their spectra recorded. The first of them is about 4′ long by 2′ broad, and has been described as "a streak tapering at each end"; in the General Catalogue it is described as "pretty bright; considerably large; much elongated in the direction 11°·9; between two stars." The second is described as "considerably bright; pretty small; irregularly round; pretty suddenly brighter in the middle." They are both very conveniently situated for observation.

(3) The spectrum of this star is a very fine one of Group II., all the bands being wide and dark. Carbon comparisons will probably be the most valuable observations of this star, the character of the spectrum indicating that the flutings should be considerably bright.

(4) Secchi thought that this star had a banded spectrum, but Dunér states that it is one of the solar type ("Sp. II.*a*! du type le plus pur"). It still requires observing with reference to Groups III. and V.

(5) The spectrum of this star is one of the very finest of its class (Group VI.). It has been observed in considerable detail by Vogel and Dunér. All the principal and secondary bands are well visible. The carbon band 6 (λ 564) is stated by Dunér to be feebler than the others, and so far as we yet know this is the only band in which any considerable variation is established. It will be remembered that this is the cometary band which varies most, but in comets it varies in position also. It seems possible, therefore, that it may also change in position as well as in intensity in stars of Group VI. Comparisons with a spirit-lamp flame would easily decide this point.

(6) This variable has a well-marked spectrum of Group II. Dunér describes it as "very fine," and states that the bands are very wide and dark throughout the spectrum. The period is about 345 days, and it ranges from 6·4–7·4 at maximum to 10·9–11·2 at minimum. The star falls in species 9 of the subdivision of Group II., and if it behaves like other variables with similar spectra, bright lines should appear at or about maximum. The spectrum should also be observed for brightenings of the carbon flutings. A. FOWLER.

OBSERVATIONS OF COMETS.—Prof. E. E. Barnard, of Lick Observatory, contributes a note on Comets 1889 I. and II. to the *Astronomical Journal*, No. 225, and makes some suggestions as to the possibility of seeing the short-period comets at aphelion. The majority of observers neglect comets as soon as they become faint or difficult to see. Prof. Barnard has made it a point to take up comets when they have been dropped elsewhere, and to observe them as long as they can be seen. Comet 1889 I. has been observed at Lick Observatory from September 2, 1888, to August 18, 1890—that is, for very nearly two years; and Comet 1889 II. from March 31, 1889, to August 24, 1890—that is, for 16 months 24 days: hence the duration of visibility of each exceeds that of the great comet of 1811, which was followed for 16 months 20 days. At the observation of Comet I. 1889, on August 17, its distance from the sun was 6·25 times the earth's mean distance. On August 24, Comet II. 1889 was 5·06 times the same unit from the sun, and Prof. Barnard thinks he will be able to follow it for quite six months longer. The following are the aphelion distances of short-period comets (excepting Tuttle's) recognized at more than one return:—

Encke's	4·10	Brorsen's ...	5·66
Tempel's II. ...	4·66	D'Arrest's ...	5·72
Tempel's I. ...	4·82	Faye's ...	5·92
Swift's 1880 ...	5·14	Biela's ...	6·19
Winnecke's ...	5·50		

It will be seen that Comet I. 1889 is now being observed at a distance from the sun greater than it is possible for any of the short-period comets to attain. It would appear, therefore, that some of the latter class of comets ought to be followed throughout their entire orbits.

PHOTOGRAPHING STARS IN THE DAYTIME.—In the *Astronomical Journal* for September 16, 1889, Prof. Holden gave an elementary theory of the subject of photographing stars projected against a bright background. He showed that, if the intrinsic brilliancy of a star be ten times as great as its background, the photographic image in the Lick telescope was 4124 times brighter than that of the sky. It was also proved that small photographic contrasts of this character could be increased with a given telescope by simply cutting down the aperture. Recently, Prof. Holden writes (*Astr. Journ.*, September 19, 1890), "the question has been examined experimentally by Mr. W. W. Campbell and myself, using the great telescope (focus, 570 inches) and apertures of 33, 15, 8, and 4 inches. Photographs of Venus, Mercury, the moon, and of Alpha Lyræ have been taken in broad daylight (2 to 5 p.m.) with the apertures named, with a constant exposure of 0·13s., and on Seed 26 plates. In general, the smallest apertures used have given the darkest images, as demanded by the theory."

PHYSICS AT THE BRITISH ASSOCIATION.

IN Section A, nine Reports of Committees and fifty-four papers were read. Perhaps the distinguishing characteristic of the Section is its tendency to bifurcation on the slightest provocation. Several Sections do not meet at all on the Saturday, and manage to get through their business comfortably by the Tuesday. Not so Section A. On the Saturday, under the influence of electrolytical attractions and repulsions, there occurred a dissociation of the Section into its constituent elements, accompanied by a migration of ions from places of high potential (in a Bramwellian sense) to places of low, or *vice versâ*. In accordance with the law of ionic migration enunciated by Sir Frederick at the concluding meeting, the ions collected at the

kathode were found to far exceed in number those collected at the anode.

To give even an outline of all the voluminous and multitudinous contributions to the Section would occupy many pages, and would require that the writer should have received the training of a Succi or a Jacques before undertaking the task.

M. Du Bois read a paper on refraction and dispersion in certain metals. Kundt's method of observation with very thin electrolytic metal biprisms was used in this investigation. The dispersion was determined with all possible care, using four kinds of light defined by spectral lines. It was found that light, on passing from iron, cobalt, and nickel into air, begins by following Snell's law for small angles of emission, the refractive index being mathematically defined as the limit of the ratio of sines when the angle of incidence approaches the limit zero. The dispersion in the case of each of the three metals mentioned was found to be anomalous.

Sir William Thomson, F.R.S., in a paper on an illustration of contact electricity presented by the multicellular voltmeter, called attention to the modification of the force between the aluminium needles and the brass cells of the instrument arising from the "contact electricity" difference between polished brass and polished aluminium. In the instrument as at present made, the observed difference of potential on reversal amounts to as much as ¼ volt. Thus the use of the multicellular electrometer gives a new and very interesting direct proof of Volta's contact electricity.

Lord Rayleigh, Sec.R.S., read a paper on defective colour-vision, in which he pointed out that the existence of a defect is probably most easily detected, in the first instance, by Holmgren's wool test; but this method does not decide whether the vision is truly dichromic. For this purpose, Maxwell's colour-disks may be used. Lord Rayleigh found, in the case of some colour-blind persons he was examining, that it looked as though the third colour-sensation, presumably red, was defective, but not absolutely missing. When a large amount of white was present, matches could be made, in spite of considerable difference in the red component. But when red light was nearly isolated, its distinctive character became apparent. This view was confirmed by experiments with the colour-box.

Mr. J. Swinburne, in a paper dealing with the question of the production of high vacua, called attention to the great superiority of the Geissler over the Sprengel form of mercury pump.

Profs. Barr and W. Stroud, in a paper on the use of the lantern in class-room work, described a simple and convenient form of lantern for horizontal and vertical projection, and exhibited an apparatus for the preparation of lantern-slides in large numbers from books, periodicals, &c.

Mr. W. N. Shaw read a paper on the general theory of ventilation, with some applications, in which general laws of ventilation are established similar to Kirchhoff's laws relating to the distribution of currents in a network of conductors.

On Friday, September 5, there was a discussion on electrical units, opened by Mr. Glazebrook with a paper on recent determinations of the absolute resistance of mercury, in which he carefully compared and criticised the different methods employed by various observers. The best determinations of the ohm showed that it was very nearly indeed equal to the resistance of a column of mercury 106·3 cm. long and 1 square millimetre cross-section at 0° C. Mr. Glazebrook strongly advocated the adoption of the number 106·3 instead of 106; and Sir William Thomson, Prof. Rowland, Prof. Barker, and Mr. Preece expressed their concurrence in the desirability of the change.

Principal J. V. Jones followed with a paper entitled "Suggestions towards a Determination of the Ohm," in which he described the results of experiments undertaken at University College, Cardiff, in the spring of the present year. These experiments gave the ohm equal to the resistance of a column of mercury 106·307 cm. long and 1 sq. mm. sectional area. The method adopted was a modification of that due to Lorenz, in which a metallic disk is made to rotate in the mean plane of a coaxial standard coil. Wires touching the centre and circumference of the disk are led to the ends of the resistance to be measured, and the same current is passed through this resistance and the standard coil.

The features of special interest in the method employed were:—(α) The employment of a long trough for holding the mercury; and, instead of measuring the distance between the electrodes, one electrode is kept fixed, while measurement is made of the distance moved through by the other between two positions of equilibrium of the galvanometer corresponding to two different rates of rotation of the disk. The latter measurement it is easy to make with accuracy, for the movable electrode may be rigidly attached to the movable headstock of a Whitworth measuring-machine placed parallel to the length of the trough; and the two equilibrium positions may be taken near the middle of the trough, so as to avoid danger of curvature in the equipotential surfaces passing through the electrode in its two positions. A new difficulty is, however, now encountered, viz. the determination of the section of the mercury column. The capillary depression at the sides of the trough would make it a most serious task to determine the section by direct measurements to the required degree of accuracy. This difficulty is overcome by a further differential method, viz. by making observations with the mercury at two different heights in the trough. The sides of the trough in that part of it traversed by the movable electrode are assumed plane, parallel, and vertical. The trough used in the experiments was cut in paraffin wax contained in a strong casting of iron with its sides strengthened by outside ribs. The channel was 43·5 inches long, by 1·5 inches broad, by 3 inches deep. Paraffin was found, however, not to be perfectly satisfactory, and Prof. Jones expressed the opinion that a trough of worked glass or scraped marble would have been preferable. The position of the mercury surface in the trough was determined electrically by using a pointed steel spherometer screw. The screw may be moved downwards until an electric circuit comprising the screw and the mercury is completed. (β) The employment of a brush of special form to secure good electrical contact at the periphery of the rotating disk. The brush consisted of a single wire perforated by a channel through which a constant flow of mercury might be maintained from a cistern of adjustable height. (γ) In connection with the measurements necessary to enable the calculation of the coefficient of mutual induction to be performed, Prof. Jones employs a coil consisting of only one layer of wire, the advantage of which is that every part is visible, and that nothing is done to alter the position of the wire after measurements have been made. If a coil consist of many layers, it is not quite easy to say where, after measurement, the lower layers go to under the pressure of the superincumbent ones.

In conclusion, the main suggestions offered for consideration, were:—

(1) That the time is ripe for a new determination of the ohm that shall be final for the practical purposes of the electrical engineer.

(2) That such a determination may be made by the method of Lorenz, the specific resistance of mercury being obtained directly in absolute measure by the differential method described.

(3) That the standard coil should consist of a single layer of wire, the coefficient of mutual induction being calculated by the formula given in the paper.

Sir William Thomson, in a paper on alternate currents in parallel conductors of homogeneous or heterogeneous substance, pointed out that when the period of alternation is large in comparison with 400 times the square of the greatest thickness or diameter of any of the conductors, multiplied by its magnetic permeability and divided by its electric resistivity, the current intensity is distributed through each conductor inversely as the electric resistivity; the phase of alternation of the current is the same as the phase of the electromotive force; and the current across every infinitesimal area of the cross-section is calculated, according to the electromotive force at each instant, by simple application of Ohm's law. Further, that when the period is very small compared with 400 times the square of the smallest thickness or diameter of any of the conductors, multiplied by its magnetic permeability and divided by its electric resistivity, the current is confined to an exceedingly thin surface-stratum of the conductors. The thickness of this stratum is directly as the square root of the quotient of resistivity, divided by magnetic permeability, of the substance in different parts of the surface. The dependence of the total quantity of electricity carried on extent of surface justifies Snow Harris, and proves that those who condemned him out of Ohm's law were wrong, in respect to his advising tubes or broad plates for lightning conductors, but does not justify him in bringing them down in the interior of a ship (even through the powder magazine) instead of across the deck and down its sides, or from the masts along the rigging and down the sides into the water.

Sir William Thomson read a paper on anti-effective copper in parallel conductors, or in coiled conductors for alternate currents. It is known that by making the conductors of a circuit too thick

we do not get the advantage of the whole conductivity of the metal for alternate currents. When the conductor is too thick, we have in part of it comparatively ineffective copper present; but, so far as is known, it has generally been supposed that the thicker the conductor the greater will be its whole effective conductance, and that thickening it too much can never do worse than add comparatively ineffective copper to that which is most effective in conveying the current. It might, however, be expected that we could get a positive augmentation of the effective ohmic resistance, because we know that the presence of copper in the neighbourhood of a circuit carrying alternating currents causes a virtual increase of the apparent ohmic resistance of the circuit in virtue of the heat generated by the currents induced in it. May it not be that anti-effective influence such as is thus produced by copper not forming part of the circuit can be produced by copper actually in the circuit, if too thick? Examining the question mathematically, Sir William finds that it must be answered in the affirmative, and that great augmentation of the effective ohmic resistance is actually produced if the conductor is too thick, especially in coils consisting of several layers of wire laid one over another in series around a cylindric or flat core, as in various forms of transformer.

Prof. J. A. Ewing, in a most interesting and important communication (*vide Phil. Mag.*, September 1890), exhibited a model to illustrate some novel ideas on the molecular theory of induced magnetism. The present notion of a quasi-frictional resistance opposing the turning of the molecular magnets lends itself well to account for the most obvious effects of magnetic hysteresis and the reduction of hysteresis by vibration. On the other hand, it conflicts with the fact that even the feeblest magnetic force induces some magnetism. Reference was made to another (and not at all arbitrary) condition of constraint, which not only suffices to explain all the phenomena of hysteresis, without any notion of friction, but seems to have in it abundant capability to account for every complexity of magnetic quality. Prof. Ewing supposes that each molecular magnet is perfectly free to turn except in so far as it is influenced by the mutual action of the entire system of molecular magnets. A model molecular structure was exhibited, consisting of a large number of short steel bar-magnets strongly magnetized, each pivoted upon a sharp vertical centre, and balanced to swing horizontally. The bars swing with but little friction, and their pole-strengths are sufficient to make the mutual forces quite mask the earth's directive force when they are set moderately near one another. The group is arranged on a board which slips into a large frame wound round the top, bottom, and two sides, with a coil, through which an adjustable current may be passed to expose the group to a nearly homogeneous external magnetic force.

Sir William Thomson read a paper on a method of determining in absolute measure the magnetic susceptibility of diamagnetic and feebly magnetic solids. The method proposed consisted in measuring the mechanical force experienced by a properly shaped portion of the substance investigated, placed with different parts of it in portions of magnetic field between which there was a large difference of the magnetic force. A cylindrical or rectangular or prismatic shape terminated by planes perpendicular to its length was the form chosen; the component magnetic force in the direction of its length was equal to $\frac{1}{2}\mu(R^2 - R'^2)A$; where μ denotes the magnetic susceptibility, R R′ the magnetic force in the portions of the field occupied by its two ends, and A the area of its cross-section.

Lord Rayleigh read a paper on the tension of water surfaces, clear and contaminated, investigated by the method of ripples. The ripples were rendered visible by a combination of Foucault's optical arrangement with intermittent illumination. Two frequencies were used, about 43 and 128 per second. The surface-tension of a clean water surface, in c g.s. measure, was found to be 74·0, thus confirming observations made with capillary tubes. Water saturated with olive oil had a surface-tension of 41·0, and saturated with oleate of soda a surface-tension of 25·0.

Mr. W. N. Shaw reported on the state of our knowledge of electrolysis and electro-chemistry.

Mr. J. Hopkinson read a paper on the inland compared with the maritime climate of England and Wales. For special reasons Buxton, Woburn (Apsley Guise), Croydon, Cheltenham, and Churchstoke were chosen to represent the interior of the country, while Scarborough, Lowestoft, Babbacombe, Worthing, and Llandudno were chosen to represent the sea-coast. The places were so chosen that the mean position, latitude, and longitude of the five inland places should closely approximate to those of the maritime. As the result of observations extending over the decade from 1880–89, he concluded that, so far as regards our comfort and most probably also our health, our maritime climate is on the whole superior to our inland climate, being warmer, owing (it is most important to observe) to the nights not being so cold, while the days are no hotter, the extremes of temperature being much less, the air rather less humid, the sky less cloudy, and the rainfall less.

Prof. Ramsay read a paper on the adiabatic curves for ether, gas and liquid, at high temperatures. The method adopted in the experiments was an ingenious one, and consisted in determining the velocity of sound in the vapour by Kundt's dust-figures, from observation of the wave-length and the pitch of the note emitted by the stroked tube containing the vapour. This process gives the ratio of adiabatic and isothermal elasticity from which the former elasticity can be calculated as the latter is known.

Prof. Ostwald read an interesting paper on the action of semi-permeable membranes in electrolysis, in which he gave an account of experiments upon the passage of an electric current through solutions in series separated by semi-permeable membranes, and pointed out the importance of such phenomena to physiology. He explained that a semi-permeable membrane would allow ions of one kind to pass through, but arrest ions of another kind, and thus act as though it were a metallic electrode.

Prof. C. Piazzi Smyth sent a paper on photographs of the invisible in solar spectroscopy. Two photographs were shown, each measuring 40 inches long × 20 inches high. They represent in reality, only very small portions of the faint ultra-violet of the solar spectrum, but on a whole scale of 57 feet long from red to violet; and are located quite outside the spectral limit of variability to the human eye, with the grating spectroscope concerned, whether under summer or winter sun.

Profs. Rücker and Thorpe contributed a paper on regional magnetic disturbances in the United Kingdom, and this was followed by a paper upon similar disturbances in France, by Prof. Mascart. A point of great interest in connection with these papers was the continuous nature of the disturbances extending from the one country across the Channel to the other.

Prof. Lodge, in a paper on electrostatic forces between conductors, gave an account of an investigation into the forces between electric resonators as examined experimentally by Boys, and therefrom branched out into several allied subjects connected with the mechanical forces of electric pulses and waves.

Prof. Fitzgerald communicated several papers on mathematical physics to the Section. One of these bore what would have been an attractive title, "An Episode in the Life of J," had it not been for a parenthetical addition, viz. "(Hertz's Solution of Maxwell's Equations)." It may be remarked that J has nothing to do with Joule or his equivalent, and that the episode referred to was not of the popular anecdotal type.

Mr. W. Barlow, in a paper on atom-grouping in crystals, called attention to some very interesting properties of the simpler kind of symmetrical grouping of points, and pointed out an easy and effectual method of studying them by using a model consisting of equidistant parallel planes of homogeneously distributed points represented by beads.

Mr. W. H. Preece read a paper on the character of steel used for permanent magnets. Samples of steel for the experiments were obtained from all the leading firms, and after magnetization were tested by a magnetometric method. The marked superiority of the Marchal magnets over those made of English steel is due either to the quality of the steel, or to the mode of tempering—most probably the latter.

Prof. S. P. Thompson read a paper on the use of fluor spar in optical instruments, in which he referred to the existing uses of fluor spar for experiments on radiant heat, and in the "apochromatic" microscope lenses of Zeiss. The latter application derives its importance from the extremely low dispersion relatively to the mean refractive power of the material. To these applications the author now added that of the construction of spectroscopic direct-vision prisms; and he described two prisms, both constructed for him by Mr. C. D. Ahrens—one consisting of a fluor prism cemented between two flint-glass prisms, and the second consisting of one Iceland-spar prism cemented between two fluor prisms. The former was considerably shorter than the ordinary direct-vision prism of equal power: the latter had the property of polarizing the light as well as dispersing it, and presented the novel feature of a true polarispectroscope.

Mr. F. T. Trouton read a paper advocating the introduction of a coefficient of abrasion as an absolute measure of hardness.

Mr. F. H. Varley exhibited and explained the action of a new direct-reading photometer—an ingenious and compact instrument, in which intermittent illumination is employed for equalizing the intensity of illumination from two sources of light.

BIOLOGY AT THE BRITISH ASSOCIATION.

ALTHOUGH the number of papers in Section D was not quite so large as usual, it was found sufficient to occupy the time fully. As on previous occasions, the most attractive part of the proceedings was a discussion on a subject of general interest arranged beforehand, and opened by set papers.

After the President's address on Thursday, Prof. Newton gave an interesting account of the ornithology of the Sandwich Islands, discussing its peculiarities and probable affinities. He showed that the fauna is now undergoing modification, and is in danger of extermination on account of the changes which are rapidly being made in the vegetation of the islands; and he urged strongly the necessity of making a thorough examination of the fauna and flora of this important region while it is still possible. This paper led to the appointment of a committee, with a grant, for the purpose of seeing that the necessary exploration was carried out at once.

The usual reports on the zoology and botany of the West India Islands, on the migration of birds, on the disappearance of native plants, on a deep-sea tow-net, on the Botanical Station at Peradeniya, Ceylon, on the Biological Laboratory at Plymouth, and on the Zoological Station at Naples, were read, and the committees were reappointed.

The greater part of Friday's meeting was occupied by an important and interesting discussion on the teaching of botany, and especially the teaching in schools or to the young. The subject was opened with papers by Prof. Marshall Ward, Prof. F. W. Oliver, and Prof. F. O. Bower. Prof. Marshall Ward discussed the teaching of botany under the three heads: (1) elementary or school teaching; (2) more advanced or academic teaching; and (3) applied or special botany, such as forestry. He urged strongly the advantages of an early training in botany, and showed the suitability of the subject for school teaching, not however from books, but practically, and especially by means of field-work. In the teaching of applied botany he considered that principles and generalizations were of more importance than masses of facts, even in the training of the so-called practical man.

Prof. Oliver treated chiefly of the teaching of elementary botany to medical students at our colleges; and Prof. Bower dealt also with the arrangement of the usual junior University course, which he considered should be wide in its range and suggestive, rather than more restricted and exhaustive.

A number of other teachers of botany joined in the discussion; and Dr. Forsyth, of the Leeds Higher Grade School, showed that many of the suggestions which had been made were being carried out at his school, where the pupils were taken periodically to the fields to collect the specimens for their object lessons.

Prof. Marsh then gave an interesting account of the Cretaceous mammals of North America, of which he had now in his possession over 1000 specimens, all obtained during the last year or so. These remains all appear to belong to the lower forms of Mammalia, such as Monotremes and Marsupials, and are all of small size, although they are found in the same beds with the gigantic Dinosaurs, such as *Triceratops*.

Prof. Denny gave an account of an abnormality which he had found in three successive seasons in some flowers of *Tropæolum*, and which consisted in the inversion and in some cases duplication of the spur. Prof. Denny suggested that these abnormal flowers seeemed to indicate that the spur was really the representative of the two missing stamens.

Canon Tristram contributed some notes on the natural history of Hierro and Graciosa, two outlying islands of the Canary Group. A paper by Mr. E. H. Hankin dealt with the modifying action of ferments, such as trypsin and pepsin, upon diseases caused by bacteria, *e.g.* anthrax. It is suggested that the injection of the ferment causes a "defensive proteid" to be formed and thrown into the circulation for the purpose of killing the bacteria.

On Monday, Prof. Miall and Mr. Hammond gave an account of the development of the head of the adult fly in the life-history of the dipterous insect *Chironomus*, commonly found in impure water. Prof. Marshall and Mr. Bles called attention to variability in development amongst allied animals, and even amongst individuals of the same species. Dr. P. H. Carpenter contributed notes on the anatomy and morphology of the Cystidea.

Mr. S. F. Harmer discussed the regeneration of lost parts in the Polyzoa, including the formation of new polypites in *Pedicellina* on the tips of the old stalks where no endodermal tissues are present. Dr. S. J. Hickson gave two papers on the Hydrocorallina—the one dealing with the meaning of the ampullæ in *Millepora murrayi*, which were found to contain modified dactylozooids bearing only very large sperm sacs; and the other being on the gonangia of *Distichopora* and *Allopora*. An important conclusion drawn from these investigations was that, as regards the position and character of the gonads, *Millepora* is not related to any of the Stylasteridæ.

Amongst a number of botanical papers read on Tuesday were: one by Mr. R. Warrington, showing that certain bacteria have the power, usually supposed to be peculiar to chlorophyll-bearing organisms, of forming organic compounds from inorganic materials; one by Prof. Bower, on the phylogenetic relationships between the different groups of Ferns; one by Prof. P. Geddes, on the origin of protandry and protogyny; and one by Dr. J. M. Macfarlane, on hybrids, in which it was shown from a number of genera of plants that certain hybrids which had been produced were intermediate, not only in appearance and general structure, but even in the most minute histological details, between the two parent species.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

IN the quality and scientific value of the papers, this Section was considerably above the average of last year. There were only about a score of papers altogether, but the Organizing Committee had determined rather to be short of papers than to accept any of trivial importance. As it was, the time of the Section during the four days on which it met was well filled up. The sittings were well attended, and sometimes almost crowded; which is saying much, considering the size of the hall in which the Section met. The Section adopted a plan which answered admirably. It adjourned each day from 1 to 2 p.m., and invariably a good audience assembled for the afternoon meeting.

The hall was well filled at the President's address, which was an excellent *résumé* of the physical geography of the Mediterranean and the regions around its shores. On two other occasions the lower part of the hall was quite filled by audiences evidently greatly interested. First, on the Monday, when there was a joint meeting of Sections E and F to discuss the important subject of the Lands of the Globe still available for European Settlement. Mr. E. G. Ravenstein opened the conference with a paper giving what may be called the geography of the subject. He excluded from consideration the Polar areas, desert areas, and tropical areas unsuited to a European population. He showed that, dealing with the subject from a purely theoretical point of view, the population of the world, at the present rate of increase, would, in about three or four generations, amount to something like 5000 millions. This, of course, sounds very alarming, but as in the case of the prediction of the exhaustion of our coal supply, it was shown during the discussion that we may keep our minds at ease. Prof. Marshall, Sir Rawson Rawson, Dr. Cunninghame, Mr. Bourne, and others who took part in the subsequent discussion, mainly from the economical point of view, suggested various considerations in modification of those derived from the purely theoretical standpoint. The earth has still vast undeveloped resources; a more equable distribution of these among mankind is possible, and even desirable; the theoretical rate of increase will certainly be modified in various ways; the so-called deserts may, actual experiment has shown, be made, by means of irrigation from underground supplies, both fertile and habitable. The great truth which came clearly out of the discussion—a truth which ought to be widely realized now that tropical Africa is being opened up—is that European colonization, in the proper sense of the term, is impossible, so far as present experience goes, between the tropics. There are, no doubt, modifying circumstances in some cases, but these are rare. As usual in such discussions, there was a certain amount of irrelevant talk,

but, on the whole, the conference quite fulfilled the expectations and the object of those who arranged it.

The hall was even more crowded, with an audience even more interested, on Tuesday morning, when Miss Menie Muriel Dowie read her paper on a journey in the Eastern Carpathians. It is the fashion in certain quarters to regard Europe as beyond the pale of geography; but to all but a very few of those who listened to Miss Dowie's delightful paper, what she had to tell about the Carpathians and their people was as new as Mr. Stanley's account of his great African forest.

Africa, of course, occupied a prominent place in the proceedings of the Section, one whole day being devoted to it. Dr. Kerr Cross, who has been stationed for many years in the Lake Nyassa region, and is well qualified for scientific observation, read a paper on the interesting plateau country lying between Lakes Nyassa, Hikwa or Leopold, and Tanganyika. The paper gave a most instructive picture of the extensive and varied area with which Dr. Cross is familiar. The information he gave about the little-known Lake Hikwa, east of the south end of Tanganyika, was specially valuable, as it had only been seen at a distance before by Mr. Joseph Thomson and a German explorer. It is brackish, of a long curved shape, and lies in a deep depression of the plateau, its basin being a parched-up wilderness. Though there has been abundant rain on the plateau around, for three years not a drop has fallen in the lake valley. Mr. E. A. Maund described in some detail Matabeleland, where he himself has resided for some years. Dr. R. A. Freeman's account of his journeys in Ashánti and neighbouring regions was of special novelty and value. The paper described a journey through a tract of country in and to the north of Upper Guinea, comprising the territories of Fánti, Assín, Ádánsi, Ashánti, Jáman, and Grúinsi. The tract extends from 5° N. to 10° N., and from 0° to 4° W. The first four countries are inhabited by various branches of the great Otshwí family, and the remainder by certain pagan aboriginal tribes, and by numbers of Wongára or Mandingo immigrants. Journeying from Cape Coast, through Ashánti to Bontúku, the capital of Jáman, the author crossed three zones of country: (1) open country covered with low bush about 30 miles broad; (2) dense forest about 180 miles broad; (3) open park-like country which, alternating with grassy plains, seems to occupy the greater part of Central and Eastern Africa. On arrival at Kumassi, the capital of Ashánti, the author was received by the king and principal chiefs with great ceremony, the court of Kumassi retaining much of its former splendour. The town of Kumassi is much dilapidated, but presents many relics of great interest. Jáman is a kingdom situated to the north-west of Ashánti, about 9300 square miles in extent; its capital, Bontúku, is a large town closely resembling in appearance the towns of the Tawarek and Upper Niger. It is inhabited almost exclusively by Mahommedans, and forms an important slave depot, as do also the Grúinsi towns of Wà and Bóri. The commercial resources of the tract of country here described are considerable; over the whole of it gold is fairly plentiful, and the forest abounds in rubber plants both in the form of trees and vines. Hard woods are very plentiful, and are of great value in Europe, notably the Odúm and Pappáo, both of which trees reach a height of nearly 200 feet. The Kola nut also, which grows abundantly in the forest, has a great and increasing commercial value. The country is intersected by several considerable rivers which might be easily rendered navigable, and thus form great highways of trade. There are, moreover, no special obstacles to the construction of railways, and the district may thus be expected to form one of the great commercial centres of the future.

Mr. J. S. Keltie's paper on the Commercial Geography of Africa dealt with the varied physical conditions of the continent, and endeavoured to indicate the bearings of these on its industrial development and colonization. It was shown that the vast tropical region, in which Nature is most exuberant, is of insignificant commercial value compared with the countries along the Mediterranean and the region south of the Zambesi. Central Africa will only become of commercial value when, as in North and South Africa, man is able actively to interfere; the spontaneous animal and vegetable products of tropical countries can never be of great commercial importance.

Mr. A. Silva White followed with a paper showing in detail the partition of Africa among the Powers of Europe.

Two other papers of special African interest were read by Mr. Cope Whitehouse and Dr. Schlichter. The former sought to prove that in the oldest Ptolemaic maps a depression (Lacus Meridis) is shown, exactly corresponding to the Wadi Ráyan and Wadi Mullah. Dr. Schlichter, in an elaborate paper, discussed the whole subject of Ptolemy's knowledge of North-East Africa, and sought to show that many of his positions exactly corresponded with those of modern maps, obtained by quite recent explorations.

There were three papers connected with Asia. Mr. Theodore Bent's paper on his recent explorations in North-Eastern Cilicia was mainly of an archæological character. Sir Frederic Goldsmid read a paper on a railway through Southern Persia, as a link of communication in the great railway route that will one day connect England with India. Surveys and reports by recent travellers have rendered it easy to supply this link, which may be appropriately called the Baghdad-Bandar-Abbas section, or, more minutely, the Baghdad-Shiráz and Shiráz-Bandar-Abbas sections. As to the route from Bandar-Abbas to Karáchi on the east, and from Tripoli to Baghdad on the west, any doubts or difficulties that present themselves are already ripe for discussion, and their solution cannot be treated as dependent upon further travel and research. It is proposed to carry the line from Baghdad through Persian Arabistan, either by way of Dizful and Shustar, continuing along the recognized track from the latter place to Bebehan; or by an alternative route down the left bank of the Tigris, and *viâ* Haweizah to Ahwaz, whence Major Wells, R.E., has furnished full details of route from his own experiences. The same officer has made, moreover, very valuable suggestions on the mode of reaching Shiráz from Bebehan.

Mr. H. F. B. Lynch dealt with an allied subject in his paper on new trade routes into Persia. In the course of the paper Mr. Lynch, from his own personal knowledge, gave much information as to the physical geography of Persia, and especially the region watered by the Karun River.

South America was dealt with in two papers. Mr. J. W. Wells described the physical geography of Brazil in its bearing on the industrial development of the country, and M. A. Thouar sent an abstract narrative of his journeys during the past few years in the Argentine, Peru, and Bolivia.

Mr. Coutts Trotter gave a most useful summary of exploration in British New Guinea in recent years, dealing mainly with Sir W. Macgregor's journey to the summit of the Owen Stanley Range, already described in NATURE.

Dr. H. R. Mill gave a *résumé* of his investigations on the vertical relief of the globe, details of which have been published in the *Scottish Geographical Magazine*. He also gave an interesting account of his observations on the methods of teaching geography in Russia and of Russian geographical text-books.

Mr. Henry T. Crook's paper on the present state of the Ordnance Survey, and the paramount necessity for a thorough revision, led to the Sectional Committee's requesting the Council of the Association to move the Government to take steps for the rapid completion of the Survey, and for rendering the Ordnance maps much more accessible for purchase by the general public than they are at present.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

ON Thursday, September 4, after the President's address, a paper by the Rev. F. O. Morris, on the doctrine of hereditism was read, and gave rise to a lively discussion, or rather a chorus of condemnation of the views advanced by the author.

In a paper by Mr. Horatio Hale, which forms the introduction to the Report of the North-Western Tribes of Canada Committee, attention was called to some of the chief peculiarities of British Columbian ethnography, the great number of linguistic stocks which are found in this comparatively small territory and the singular manner in which they are distributed, especially the surprising variety of stocks clustered along the coast as contrasted with the wide sweep of the languages of the interior. All the languages of British Columbia have a peculiar phonology; their pronunciation is singularly harsh and indistinct; and it would appear that this is due mainly to climatic influences, for, south of the Columbia River, the harsh utterance suddenly ceases and gives place to softer sounds.

A paper by Mr. J. W. Fawcett was read on the religion of the Australian aborigines. The author stated that the Australians believe in a Creator, in a future life, and in good and

evil spirits. They have a strict sense of right and wrong, and have religious ceremonies, which are always held in secret on ground that is held very sacred, so much so that if it is touched by the foot of a white person it loses all sanctity.

Another paper by Mr. Fawcett was read on the aborigines of Australia, in which he traversed certain statements that have been made by Mr. Carl Lumholtz.

On Friday, September 5, Mr. F. W. Rudler, who, in the absence of Dr. Evans, presided over the Section, read a paper on the present aspect of the jade question.

It has long been known that implements worked in jade have occasionally been found in ancient graves in France and Western Germany, and in certain Neolithic stations on the Swiss lakes. Some of these implements are wrought in nephrite, or true jade, and others in jadeite. As neither of these minerals had been found *in situ* in Europe, while both were known to occur in Asia, it had been conjectured that the European jade implements must have had an Oriental source, and that either the implements themselves or the raw materials of which they were made had been brought to Europe in prehistoric times. But within the last few years Herr Traube, of Breslau, has discovered nephrite *in place* near Jordansmühl, and near Reichenstein, in Silesia. Pebbles of nephrite have also been recently recorded, by Dr. Berwerth, from the valleys of the Mur and the Sann, two rivers in Styria. A pebble believed to be of jadeite was found by M. Damour at Ouchy, on the Lake of Geneva, and the same mineral has been recorded from Monte Viso, in Piedmont.

Jade implements are found along the coast of British Columbia and Alaska, and it has been suggested that these, or the raw jade, had been obtained from Siberia, where the occurrence of nephrite is well known. Dr. G. M. Dawson has, however, recorded the discovery of small boulders of jade, partially worked, in the lower part of the Frazer River Valley; and Lieutenant Stoney has obtained the mineral *in situ* at the Jade Mountains in Alaska, 150 miles from above the mouth of the River Kowak.

The present aspect of the jade question is, therefore, quite different from that which it presented when the late Prof. H. Fischer and others strongly favoured the view that the jade implements of Europe and America had an exotic origin. In both these continents jade has now been found *in situ*, and it seems, therefore, probable that the material of the implements is indigenous, as maintained by Dr. A. B. Meyer for those of the Old World, and by Dr. Dawson, Prof. F. W. Clarke, Mr. G. F. Kunz, and others, for those of the New World. If future discoveries should confirm the indigenous view, the famous jade question will be lifted out of the domain of anthropology.

A paper entitled "Is there a Break in Mental Evolution?" was contributed by the Hon. Lady Welby. The introduction of the idea of "ghost" marks mental degeneration. If the idea of "spirit" had its origin in primitive man, it would have to undergo the most primitive tests, viz. *contact*, *odour*, and *flavour*. The author contended that we must either suppose an absolute break and reversal in the evolution of mind wherein a permanently distorted picture of the universe is created, and the real and significant suddenly abdicates in favour of the baseless and unmeaning; or, we must ask whether there is some reality answering to these crude conceptions, which thus form part of a continuous mental development, and may be described as faulty *translation*, rendered inevitable by the scantiness of primitive means of analysis and expression.

To adopt the first alternative is to strike a blow at the doctrine of continuous ascent in evolution: while the second might lead us to conclude that what we want is a greater power of interpreting primitive ideas as expressed in myth and ritual, notably in relation to recent developments and present researches in psychology itself and the psychological aspects of language.

Dr. Phené read a paper on an unidentified people occupying parts of Britain in pre-Roman-British times. From extensive investigations in France, Italy, &c., he showed that certain names and words continued from Britain to the Mediterranean along ancient routes of traffic, and the works and constructions along, and in connection with, the same routes, were so alike as to be identical in design. These constructors and merchants were not British, and the traffic appears carried back long prior to the time of Cæsar.

The other papers read were on the Yourouks of Asia Minor, by Mr. T. Bent; the Aryan cradle-land, by Mr. J. Stuart Glennie; and reversions, by Miss Nina Layard. The Report of the Notes and Queries Committee was also presented.

On Monday, September 8, Dr. G. W. Hambleton read a paper on physical development, in which he described the results of a practical experiment in physical development which is being carried on at the Polytechnic Institution. Fifty per cent. of the 200 members of the author's Physical Development Society had obtained an increase of chest-girth of one inch and upwards, the average increase being a little less than two inches. In one case the increase was 6½ inches. The increase has taken place in small as well as in large chests, whether the men were tall or short, under or over twenty-one years of age, and with or without gymnastic training.

Dr. Munro described some archæological remains bearing on the question of the origin of the Anglo-Saxons in England. The relics in question have been recently brought to light on the coasts of Holland and North Germany, more especially in Friesland and the low-lying district northwards as far as the River Elbe, and show a remarkable similarity to Anglo-Saxon antiquities found in England. Dr. Munro also contributed a paper on prehistoric otter and beaver traps, in which he described some curious wooden machines which have been discovered in various peat bogs in different parts of Europe, and of which hitherto no satisfactory explanation has been offered.

Rev. E. Maule Cole read a paper on the Duggleby "Howe." This great mound on the Yorkshire wolds was opened by Mr. J. R. Mortimer on behalf of Sir Tatton Sykes in July last. The diameter of the mound was found to be over 120 feet, and the height was originally about 30 feet. In the process of excavation it turned out that there was an outer mound of rough chalk, of some 15 feet or more in thickness, surrounding an inner mound, and that the centres of the two did not exactly correspond. In the grit and lower clay were found fifty-three deposits of burnt human bones, but without any urns. Some beautiful flint weapons and tusks of the wild boar were discovered with human bodies in graves cut out of the solid rock.

Mr. J. R. Mortimer described a Romano-British graveyard in the parish of Wetwang-with-Fimber, which he believes to be the site of the long-lost Delgovitia.

Mr. Mortimer also contributed a paper on a supposed Roman camp at Octon, close to the road from York to the coast. The rectangular corners of the camp, and the width of the ditches (7½ feet) at the bottom, encourage the belief that this is not a British work, but Roman.

The other papers were on minute Neolithic implements, by Dr. H. C. March; indications of retrogression in prehistoric civilization in the Thames Valley, by Mr. H. Stopes; and a suggestion as to the boring of stone-hammers, by Mr. W. Horne.

On Tuesday, September 9, Dr. Wilberforce Smith read a paper on stethographic tracings of male and female respiratory movements. The investigation of the author, so far as it has yet proceeded, totally fails to confirm the view commonly put forth in physiological text-books that there is a natural difference between the sexes in regard to respiratory movements. Mr. W. F. Stanley exhibited and described a new spirometer, constructed upon the principle of the class of gas-meters used for testing. Dr. J. G. Garson contributed some notes on human remains found by General Pitt-Rivers, at Woodyates, Wiltshire. The measurements of the limb bones showed the stature of the persons to have been greater than that of those who were interred in Woodcuts and Rotherley. The characters of the skulls showed a considerable range of variation in size and proportion, indicating that they did not belong to a homogeneous people, but to individuals of mixed race. Variation was found not only in the facial portion, but also in the form of the calvaria. As far as the author was able to judge, the mixture is due to crossing between the Romans and the early dolichocephalic British race. There is no evidence of mixture arising from crossing between either of these races and the Celtic population.

The following papers were also read: Mr. B. Hollander, old and modern phrenology; Dr. Wilberforce Smith, diagrams for reading off indices; General Pitt-Rivers, excavation of the Wandsdyke at Woodyates; together with the report of the Anthropometric Laboratory Committee; report of the Prehistoric Inhabitants Committee; report of the Nomad Tribes of Asia Minor Committee; report of the North-Western Tribes of Canada Committee; and the report of the Indian Committee.

THE VOLCANOES OF THE TABLE LAND OF MEXICO.

THE following account with extracts is based on information gathered from a notice which appeared in the *Philadelphia Public Ledger*, sent us by the courtesy of Prof. Heilprin. He had been obliged to issue the notice in advance of the full publication of his papers by the Academy of Natural Sciences of Philadelphia, as he found on his return many varying reports of the work carried on in Mexico.

Amongst the most recent determinations of the heights of these great volcanoes are those made by the Mexican Expedition lately organized under the auspices of the Academy of Natural Sciences of Philadelphia. Prof. Heilprin has recently placed on record his barometric determinations of the four loftiest summits of the Mexican Republic: Orizaba, Popocatepetl, Ixtaccihuatl, and the Nevado de Toluca. In this paper he points out that the highest point of the Republic is the Citlaltepetl or Star Mountain, more commonly called the Peak of Orizaba, and not Popocatepetl as is generally assumed by the Mexican geographers. All his observations were made "with a carefully tested aneroid barometer, and the data were computed from almost simultaneous observations at the Mexican Central Observatory of the City of Mexico, and from barometric readings made at the sea-level at Vera Cruz. The equable condition of the atmosphere, at the time these observations were made, rendered the possibility of the occurrence of possible errors of magnitude almost *nil*." From the above quotation it will be seen that great care was taken to eliminate all errors and to get as accurate measurements as possible.

Popocatepetl was commonly accepted as the highest peak, and Alexander von Humboldt recorded it in 1804 as 17,720 feet. Since the above date, many trigonometrical surveys have been made, and the results vary from 17,200 feet to a few feet over 18,000. The latest measurements by Prof. Heilprin give 17,523 feet as the height, being 200 feet lower than Humboldt's estimate. This determination has been derived from the newer data which have been made possible through the levelling of the Mexican Railway, which was constructed a few years since, while geographers have almost universally accepted Humboldt's determinations and figures. From these new data it was shown that "the estimate of the elevation of the city of Mexico (7470 feet), and of the adjoining plateaus, which have served as a basis for most of the angle measurements of the mountains, have been placed 123 feet high. Allowing for this excess, a striking correspondence is established between the early measurements and those obtained in the spring of the year by the Philadelphia Expedition."

Prof. Heilprin and Mr. F. C. Baker made the ascent of this mountain on April 16 and 17, reaching the "rim of the crater at 11.30 o'clock on the morning of the 17th, and the culminating point early in the afternoon of the same day. Little difficulty was encountered in the ascent beyond that which is due to inconvenience arising from the highly rarefied atmosphere. The snow-field was found to be of limited extent, and not more than from five to ten feet in depth, and was virtually absent from the apex of the mountain. The surprisingly mild temperature of the summit, 45° Fahrenheit, rendered a stay of several hours in cloudland very delightful."

The supposed second highest summit of the Mexican Republic is the mountain of Orizaba or Citlaltepetl, and "the results of Prof. Heilprin's determinations show more marked variations from those of most of the earlier investigators, and more particularly from those of Humboldt." The height determined by Humboldt by means of angles taken from near the town of Galapa, was 17,375 feet, while Ferrer's determination in 1796 gave 17,879 feet, as recorded in the Transactions of the American Philosophical Society. The latter value is generally adopted by the German geographers, while the Mexican geographers, on the other hand, adopted the measurement of Humboldt, or "that which was obtained by the National Commissions of 1877, indicating a height of 17,664 feet."

The following is a short account of the ascent:—"Prof. Heilprin, with three of his scientific associates and eleven guides, made the ascent on April 6 and 7, or ten days before the ascent of Popocatepetl. The last camp, at a height of some 13,000 feet, was left shortly before five o'clock in the morning of the second day, and after a difficult and continuous struggle of twelve hours through loose boulders, sand, and a much cut up ice cap, the party—or rather the fragment which succeeded in holding out—finally reached the rim of the crater." At this point, about 120 feet below the apex of the cone, Prof. Heilprin made a measurement which indicated a total height of 18,206 feet, exceeding Ferrers and Humboldt's measures by 325 and 800 feet respectively.

As upon Popocatepetl, "the snow cap, upon Orizaba, although arising 2400 feet, or nearly half a mile above the summit of the highest peak of the Alps, was a comparatively insignificant development." The time spent on the summit was short, lasting only a quarter of an hour, and then followed the descent through the numerous seracs of the ice, which proved most difficult. At a little past eight o'clock in the evening the camp was reached, thus completing "a remarkable round of mountain climbing of fifteen successive hours."

Prof. Heilprin describes the views from the slopes of the mountain as surpassingly grand, exceeding anything that he had seen in his travels. "Far off to the west the giants Popocatepetl and Ixtaccihuatl were clearly outlined against the sky at a distance of about 100 miles, while to the east and south the eye wandered over a seemingly endless expanse of plateaus and lowlands, penetrating through a series of successive cloud planes." The measurements of both the peaks of Orizaba and Popocatepetl were made under very similar conditions of the atmosphere; the same instruments were used, and there was only an interval of ten days between the measurements, which points to the conclusion that "the first place among Mexican volcanoes must be accorded to the Star Mountain."

On the 27th of the same month the ascent of the third highest peak, called the Ixtaccihuatl, was made. The general appearance of this mountain differs considerably from the two mentioned above; instead of having a symmetrical or conical outline, it has "a strong flowing crest, covered with a heavy deposit, some 75 or 100 feet in thickness, of snow and ice, which serves readily to distinguish the familiar 'White Woman' of the plain of Anahuac."

The measurement obtained by Prof. Heilprin of the height of this mountain is 16,962 feet, which height differs by 800 to 1300 feet respectively, from those formerly obtained by the Mexican geographers. Sonntag, in the year 1857, also determined its height, and his result accords very closely (within 11 feet) with Prof. Heilprin's. The temperature on the summit was found to be lower than that on either of the other two peaks, the thermometer indicating 32° F.

In view of the close proximity of this mountain to Popocatepetl, it is difficult "to account for the low value given by Humboldt and the Mexican geographers. So nearly do they appear of equal height that the eye at first fails to distinguish which of the two summits is the higher. German geographers, however, in a few cases, have adopted Sonntag's measurements, neglecting, as in the case of Popocatepetl, to make allowances for the error in this case of 125 feet which is indicated by the levelling of the Mexican Railway."

On April 2, Prof. Heilprin and Mr. Baker ascended the fourth highest summit of the Republic, the Nevado de Toluca. The ascent of this mountain is much easier than the others, and the summit can be reached on horseback to within a distance of 900 feet. The rim of the broken crater "is extremely ragged and narrow, descending with equal abruptness to the inner and outer faces of the volcano. At some points the crest is so attenuated that it can be readily straddled." The height of this mountain was found to be 14,952 feet, which approximately corresponds to the mean between Humboldt's determination and those made by a class of students from the School of Engineers of the city of Toluca.

The results of the measurements of this mountain are very divergent, as will be seen by the following list. La Pérouse, in 1786, gave the height as less than 13,000 feet. The British Hydrographic Chart of 1872 gave 14,970 feet, and this estimate is the one which is generally followed by the English and a number of American geographers. Malespina, in 1791, by means of angles taken from positions near Fort Mulgrave, determined the height to be 17,851 feet, while Tebenkoff reduces this figure by about 900 feet.

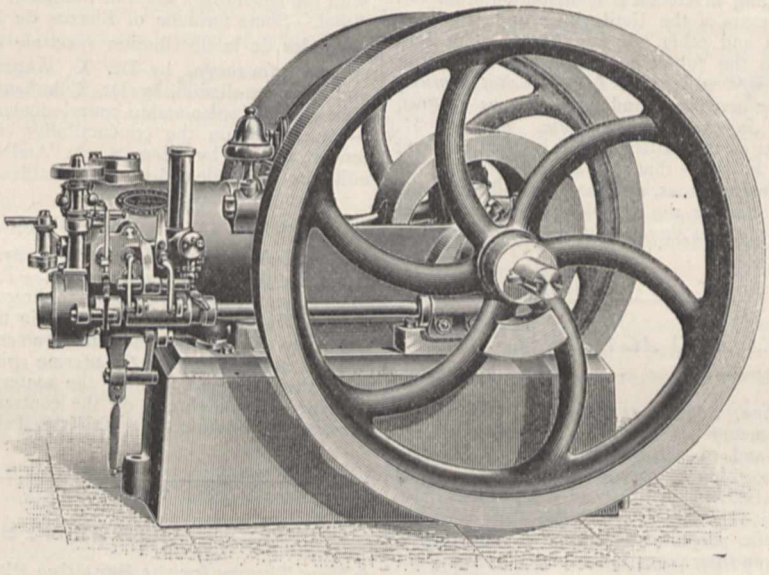
The most carefully conducted series of measurements are "those which were made by Mr. W. H. Dall, under the auspices of the United States Coast Survey, 1874. These yielded results ranging from a little more than 18,000 to nearly 20,000 feet. The measurements were made from distances 69, 127, and 167 miles, and it is more likely that the discrepancy in the results obtained is due to an uncertainty regarding the actual position of

the mountain." Even in these latter measurements we have results in which the extreme variation is about 2000 feet, and this distance compared with 4 miles (about the height of the mountain) is a large quantity, and shows that a still more accurate determination must be made before its height is placed beyond doubt.

From the results of the measurements of the heights of these four mountains, the existing evidence seems to point to the "Star Mountain" of Mexico, the peak of Orizaba, with its 18,200 feet, as the culminating point of the North American continent.

A NEW ELECTRIC LIGHT OTTO GAS-ENGINE.

ELECTRIC lighting is becoming so universal in all parts at the present day, that we give an illustration of the latest form of gas-engine made by Crossley and Brothers, Manchester. This engine, called the "High Speed Electric Light Otto Gas-Engine," runs at 250 revolutions, and is designed throughout to run at this exceptional speed. It is fitted with most of the latest improvements, such as Crossley's tube ignition, patent timing valve, and a special electric light governor, which makes it a very steady running engine for this kind of



work. The makers claim that "electric light lamps can be driven direct from the dynamo without fitting the dynamo with a fly-wheel or disc, as has hitherto been done when a small gas or steam-engine has been used; and that the light will be as absolutely steady as is possible with any form of motive power."

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for September contains an article, by Prof. H. A. Hazen, on Espy's experiments on storm generation and the liberation of latent heat on cloud-formation; these were made about 50 years ago, and Prof. Hazen states that they have never been checked, but have been accepted without question by meteorologists. His own experiments have led to different results, and he finds that deposition from *moist* air does not set free latent heat.—E. B. Garriott contributes an article on the origin of storms; he attributes their development to an excess of heat from the earth's surface by radiation, and their progressive movement to the precipitation of aqueous vapour at a considerable elevation, while the direction in which they move is regulated by the disposition of cold dry air found in areas of high pressure. For a verification of these facts, he points to the storms of the North American continent, a large majority of which originate over the great plateau region in the lee of the Pacific coast ranges of mountains, and advance towards the regions of greatest moisture which embrace the Great Lakes, the Gulf of Mexico, and the valleys of the principal rivers.—M. Faye has a supplementary article on trombes and tornadoes, for the purpose of introducing the figures illustrating his previous papers in the *Journal*.—Mr. M. W. Harrington contributes an instructive paper on forests and soil temperatures. He has taken various sets of observations published in Germany and elsewhere, amounting altogether to 150 years, and has discussed them by harmonic analysis for various periods, with the view of finding the distribution of temperatures in the soil within and out of the forest, at any depth, and at any time. The greatest difference between the forest soil and that of the open fields is at the surface, the mean difference of forest below open field being about 3°, but below the surface the differences between forest and open field do not progress uniformly. There appears to be a gain of heat in the upper soil of the woods which the open fields do not have.

American Journal of Mathematics, vol. xiii., No. 1 (Baltimore, October 1890).—The opening paper (pp. 1–52), entitled "Ueber die zu der Curve $\lambda^3\mu + \mu^3\nu + \nu^3\lambda = 0$ im projectiven Sinne gehörende mehrfache Ueberdeckung der Ebene," is by Mellen Woodman Haskell, a name not familiar to us, but belonging evidently to a mathematician of power. The discussion is exhaustive, and is fully illustrated with diagrams in the text, and two large-paged tables containing shaded diagrams. The reader who is familiar with Klein's "Ueber eine neue Art Riemann'scher Flächen" will easily follow the author's work. An index supplies the student with a ready key to the matters handled.—Prof. Cayley (pp. 53–58), in a note on a soluble quintic equation, discusses one of the equations given in Mr. Young's paper, "Soluble Quintic Equations with Commensurable Coefficients" (vol. x. pp. 99–130). The example considered is $x^5 + 3x^2 + 2x - 1 = 0$, the solutions of which the author shows admit of being put in much simpler form than those given by Mr. Young.—Then there is an instalment of a course of lectures delivered at the Johns Hopkins University during the months of January and February 1889, by Oskar Bolza. Its title is "On the Theory of Substitution-groups, and its Applications to Algebraic Equations." The paper is divided into two parts. The *first* develops the fundamental propositions, and concludes with a

short sketch of the extension of the theory to groups of operations in general. The *second part* deals with Galois's theory of algebraic equations, in particular their solution by radicals. The material is taken from Jordan, "Traité des Substitutions"; Serret, "Cours d'Algèbre Supérieure"; and Netto, "Substitutionen-Theorie." Other authors have been consulted, and the whole has been strongly influenced by a course of lectures on the subject by Prof. Klein. The editor of the *Journal* expresses a belief that this development will prove extremely useful to students.—This being the opening number of a new volume, is graced by a fine portrait of Prof. Cayley, which gives a very truthful presentment of this eminent mathematician's characteristic features.

IN the numbers of the *Journal of Botany* for August and September is an interesting mycological contribution from Dr. A. Barclay, describing some of the Ustilagineæ and Uredineæ parasitic on cereal crops and other crops in India. The most important of these are the following: *Puccinia Sorghi* on *Sorghum vulgare*, *Melampsora Lini* on *Linum usitatissimum*, *Uromyces Pisi* on *Cicer arietinum* and on *Lathyrus sativus*, *Puccinia Fagopyri* on *Fagopyrum esculentum*. Mr. W. H. Beeby contributes a paper on the British species of *Sparganium*; as regards fertilization, he states that they are rarely visited by insects; they are all proterogynous, and mostly wind-fertilized. Among the "Short Notes" is the very interesting record of the occurrence of the very rare *Ranunculus ophioglossifolius* in Gloucestershire.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 29.—M. Duchartre in the chair.—On the theory of infectious disease, of recovery, of vaccination, and of natural immunity, by M. Ch. Bouchard.—On the absorption of carbon monoxide by rocks, by M. Berthelot. Observations in mines after explosions have been said to indicate that the rocks of which the walls are constituted possess a specific property by virtue of which they retain carbon monoxide in their pores for a longer period than other gases. From some experiments made to investigate this question, M. Berthelot finds that the volume of carbon monoxide absorbed by argillaceous rocks and given up by them, is sensibly identical with the volume of air absorbed and given up under the same conditions. Hence, rocks impregnated with carbon monoxide owing to an explosion do not retain it because of any specific action peculiar to this gas.—On acetylene condensed by the silent discharge, by the same author. An examination of the result of the condensation of acetylene by means of the silent discharge appears to indicate that it differs in character from that obtained by the influence of heat on the same compound.—Spark spectrum of gadolinium, by M. Lecoq de Boisbaudran. The author gives the wave-lengths of the lines, bands, and flutings characteristic of the spectrum of gadolinium.—On the atomic weight of terbium metals, by the same author. The value found from two experiments was 159·48.—On a new safety-lamp for use in mines, by M. Charles Pollak. The lamp is an incandescent one. It weighs about 1800 grammes, and will give a light equal to 0·7 or 0·8 of a candle-power for twelve hours.—Observations of Comets Coggia and Denning (*b* and *c* 1890), made with the great equatorial of Bordeaux Observatory, by MM. G. Rayet, L. Picart, and Courty. Observations for position were made on July 27 and 29 and on August 6 in the case of the former comet, and on September 14 and 15 in the case of the latter.—Thermo-electric researches, by MM. Chassagny and H. Abraham. The authors find, from some experiments, that the variation in the electromotive force produced by heating the poles of a copper-iron couple is practically constant between 0° and 100° C. It is therefore possible that thermo-electric elements may serve as standards of electromotive force better than electro-chemical cells. The same results were found with couples two months old as with those only two days old.—On a fungus of the Mucedinean group, by M. Raphael Blanchard.—On the properties of the principal natural colouring-matters of yellow silk, and their similarity to those of carrotin, by M. Raphael Dubois. Evidence is adduced to show that raw yellow silk owes its colour to the presence of a substance analogous to the colouring-matter recently extracted from the *Diaptomus denticornis*, by M. Blanchard, and considered as a carrotin of animal origin.—The identity in the structure of lightning and discharges from an induction machine, by M. E. L. Trouvelot.

STOCKHOLM.

Royal Academy of Sciences, September 17.—On the discovery of cerium minerals and columbite, and on the occurrence of microlite, by Baron Nordenskiöld.—On the discovery of pinakiolite, trimerite, and centrolite, by G. Flink, communicated by Prof. Brögger.—On inclosures of dissimilar rocks in some Scandinavian diabases, by Herr H. Bäckström.—On maxima and minima by double integrals, by Dr. O. Kobb.—On a generalization of the Bernoullian functions, and their connection with the generalized series of Riemann, by Dr. A. Jonquière, of Basel.—Some formulæ of Bierens de Haan, by Dr. Lindman.—Études de la distribution spectrale de l'absorption dans le spectre infra-rouge, by Dr. K. Ångström.—On phenyl-totyl and benzylen-diamin, by Dr. Söderbaum and Prof. Widman.—Derivatives of ortho-amido-benzyl-alcohol, iii., by Dr. Söderbaum.—Researches on the conductibility of the caloric in porous humid bodies, by Herr S. A. Andrée, C.E.—On the new edition of the collected works of Galileo, by Dr. G. Eneström.

AMSTERDAM.

Royal Academy of Sciences, September 27.—Prof. van de Sande Bakhuysen in the chair.—Prof. Schoute dealt with some general theorems relating to directly similar plane figures.—Prof. Hubrecht described phases in the early development of the shrew's placenta, and called attention to the fact that, whereas in the hedgehog the uterine epithelium disappears—the subepithelial stroma forming the maternal contribution to the placenta—in the shrew, on the contrary, this contribution is directly derived from the epithelium of the uterus.

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