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## PRACTICAL PHYSICS

WE propose in the present article to carry out the intention expressed in a former number (vol. xii. p. 206) of giving fuller details of the practical instruction in physics, which forms a part of the summer course of instruction given to science teachers by the Science and Art Department. The teaching of practical physics presents several difficulties, which have no doubt largely militated against its general introduction into the course of scientific education. It has not yet been systematised. Unlike practical chemistry one cannot select a practical text-book on physics and give it to the students; for such text-books do not yet exist in English. We are not forgetting the translation of Weinhold's Experimental Physics, which we lately reviewed in these columns; but that book is unsuitable for most students owing to its unwieldy size and high price.

Even if works on practical physics were at hand, another difficulty is encountered in the costly nature of the apparatus involved in studying physics. This no doubt is one of the main difficulties that the teacher has to overcome, and in this respect physics differs widely from chemistry, for it is out of the question to provide a complete set of physical apparatus for every two or three students. To meet this difficulty one may distribute different instruments among the students and allow them in turn thoroughly to master what is put before them. This plan might do for a small class, the members of which could use their fingers already. But it is at best an unsatisfactory method, for it leaves the student completely at sea directly he begins to communicate the instruction he has received, unless he can purchase what he has been in the habit of using, and this is not often within his means to do. Another course is first to teach the students how to make simple apparatus for themselves, and then to show them how to use it. The advantages of this plan are apparent. Students unaccustomed to manipulation find to their astonishment, when they begin, that all their fingers have turned into thumbs, and are amazed at their clumsiness and stupidity. Very soon, however, fingers begin to reappear, and the first successful piece of apparatus that is made gives them a confidence in themselves which they had thought impossible to attain. The pleasure of having made an instrument is increased a hundred-fold when it is found that by their own handiwork they may verify some of the more important laws in physics; or make physical determinations, which before they would have considered it presumption to attempt, even with ready purchased apparatus. In order to carry out this plan successfully, minutely detailed instructions must be given to each student concerning the construction of the apparatus he has to make, and it is moreover obvious that the instruments should not take too long to make, and that the first trials should be with the simplest apparatus possible.

Let us now look at the science teachers at work at South Kensington. Each one has given to him a page of printed instructions for the day's work. These instructions have grown up within the last few years under the direction of those who have been associated with Dr. Guthrie in this undertaking, namely, Professors G. C. Foster and W. F. Barrett, together with the valuable aid of Mr. W. J. Wilson.

In the teaching of Practical Physics perhaps no subject lends itself more readily to practical work than Electricity and Magnetism; and as nearly every science student has had some little practice in this direction, this branch of physics commends itself as best fitted to begin with.

The first day's work on Electricity and Magnetism commences with the construction of simple electrical apparatus, as for example "Make a glass tube for electrical excitation;" then comes what to do in the way of cutting the tube and closing the ends. This introduces some to their first experience with the blow-pipe and the manipulation of glass, in which they rapidly gain courage and proficiency.

After this they are told to make a balanced glass tube as follows:—

"Glass tube about 12 inches × ¾ inch. Clean and dry inside, close and round one end, nearly close other end. Balance on edge of triangular file, mark centre with file. Soften one side of tube at centre with Bunsen burner, push in side with point so as to make conical cap. Avoid having file scratch at apex of cap."

Rubbers, pith balls, proof-planes are made, and the fundamental laws of electricity are tried before the day is over. Next day a gold leaf electroscope has to be made, and some capital instruments of this kind are turned out. The insulation of these electroscopes is so high that we have seen them retain a charge for an hour or more when the body of the instrument was standing in water. The secret of the insulation consists in using clean flake shellac; a little of this substance is melted in the hole through which the wire stem of the instrument has to pass, the stem is then warmed and pushed through the shellac so as to leave about a quarter of an inch thickness of shellac all round the wire. Without attempting to follow each day's work, we notice in passing that the distribution of electricity is tried by using card-board cones and cylinders covered with gilt paper, a Leyden jar with movable coatings is constructed, an electrophorus is made and various experiments tried with it, and even a Thomson's quadrant electrometer is among the more ambitious pieces of apparatus that are attempted.

Omitting Magnetism, which is not so fully developed as the other subjects, we come to Current Electricity. One of the first things that has now to be made is an astatic galvanometer, which occupies the greater part of one day's work. This instrument works so well, that for the sake of other science students we quote the following instructions for making it:—

"Wind about 50 feet of fine covered copper wire on wood block; remove wood; secure coil by tying with thread; insulate and stiffen coil by soaking with melted paraffin or shellac varnish. Make another similar coil; fix the two coils side by side on round wood block, leaving about ¼ inch space between them and soldering two of the free ends of coils together so as to make one continuous coil. Solder other two ends of wire to binding screws fixed about ½ inch from edge of block. Lead ends of the wire also into two little hollows cut in wood block by side of binding screws, so that these depressions may serve as mercury cups; they are convenient for shunting the galvanometer. Bend stout brass wire into flat-topped arch and fix firmly in block; the straight portion of wire at top of arch having upon it a cork roller for raising or lowering needles. Magnetise two sewing needles and fix (with opposite poles adjoining) ½ inch apart by means of twisted fine copper wire. On same axis, ¼ inch above upper needle, fix glass thread about 4 inches long to serve as pointer. Suspend needles by silk fibre and attach fibre to cork roller. Cut card into circle 4 inches diameter and graduate circumference into degrees. Place (but do not fix) card in proper position over coil, supporting it on two corks cemented to board. Make needles as far as possible astatic. Place them in position and cover all with glass shade."

After some preliminary work with the galvanometer, Daniell's cell and a simple form of Wheatstone's bridge are made; then a rheochord and a set of resistance coils. Then comes the following work with these instruments, in each case the necessary instructions being printed under the work to be done :—

"1. Measure relative resistances of different lengths of the same copper wire by Wheatstone's Bridge. 2. Find lengths of copper wires by measuring their relative resistances, the length of one of the wires being known. 3. Ascertain relation between resistance and weight. 4. Ascertain effect of temperature on resistance. 5. Experimentally establish the laws of divided circuits. 6. Measure the external resistance of your cell. 7. Compare the electromotive force of your cell with that of a Grove's cell."

In this direction there is, of course, an almost unlimited field for practical work, but other parts of the subject claim attention, and the time that can be given to the whole is extremely limited. Our space will not allow us to detail further what is done in this subject, nor can we give more than a hasty glance to the other subjects that are taken up in successive years by the science teachers.

Sound is not a very promising branch of Physics for practical work; nevertheless, nine or ten days are usefully spent on this subject. A monochord is the *pièce de résistance* here, and when this is made the laws of the transverse vibration of strings are verified, and the following problems solved by its means :—"1. Weigh pieces of metal of unknown weight. 2. The pitch of one tuning fork being known, ascertain that of another unknown. 3. The diameter of a German silver wire being known, ascertain its specific gravity." By means of the ordinary shilling tuning forks some useful experiments are made, and finally the velocities of sound in various solid, liquid, and gaseous bodies are determined in different ways and with a satisfactory approximation to the truth. This will indicate merely the course of practical work in this subject.

Heat and Light offer more facilities for practical work. In Heat, a differential air thermometer is first made, then an alcohol thermometer is made and graduated; the maximum density of water is tried by simple hydrometers; a bulb tube is made, and here we quote two experiments in which this bulb is used for determining coefficients of expansion :—

"Determine mean Coefficients of absolute expansion of Water and Alcohol between temperature of the day and 50° C. above.

"Weigh bulb tube filled with liquid at temperatures $t$ and $T$. Calling weight of liquid at $t$, $W$ and loss of weight at $T$, $w$, the Coefficient of apparent expansion is $\frac{w}{W - w}$. The real expansion is obtained by adding to this the Coefficient of expansion of the glass. (See next experiment.)

"Determine mean Coefficient of expansion of glass of thermometer tubing for 50° C. above the temperature of the day.

"Weigh bulb tube full of mercury at temperatures $t$ and $T$, and so obtain Coefficient of apparent expansion of mercury ($= B$). Then assuming Coefficient of real expansion of mercury as ·00018 ($= C$), $C - B =$ mean Coefficient of glass."

The determination of specific and latent heat follows this, and a few experiments on radiant heat conclude this part.

In Light a large range of subjects is available for practical work, but the necessary instruments are more numerous, and require rather more skill in their manufacture. Nevertheless several experiments will occur to every teacher, which can be made with very little preparation, such, for example, as trying the law of inverse squares, comparing in various ways the illuminating powers of different sources of light, &c. Here is something rather more difficult :—

"Make an instrument for measuring vertical heights by reflection." Instructions for this are given, and the instrument is then used for measuring the heights of ceilings, doors, &c., after it has been fully explained.

Silvering solutions are prepared and employed for many purposes; little concave and convex mirrors, for example, are made out of large watch-glasses silvered by this process of deposition, and the foci of these mirrors are then determined. A movable model is made to illustrate the law of sines; and the index of refraction of water is determined as follows :—

"Graduate slip of glass about 8 C.M. × 1 C.M. to M.M. Fix with sealing-wax two equal slips about 4 C.M. long at right angles to scale thus |——| Place in water so that uprights are just below surface. Fix an eye-tube (blackened inside) at some distance above water and in line of scale, and note division at which top of nearest upright appears on scale. Now carefully withdraw water without disturbing apparatus, and again note division. Let height of upright be $H$, and distances on scale from upright respectively $a$ and $A$, then $\frac{A}{H}$ = tangent of angle of incidence, and $\frac{a}{H}$ = tangent of angle of refraction. From tangent calculate sines, using formula sine $\theta = \frac{\tan\theta}{\sqrt{1 + \tan^2\theta}}$. Index of refraction $= \frac{\text{Sine of angle of incidence.}}{\text{Sine of angle of refraction.}}$ Verify result by varying angles."

A bisulphate of carbon lens is made from two watch glasses with ground edges, a notch being cut across to introduce the liquid. A bisulphide of carbon prism is not so easy to make; here is the method recommended :—

"Cut-off and grind ends of glass tube about 2 inches long × ¾ inch diameter so that planes of ends make an angle of about 60° with each other. Drill hole about ⅛ inch diameter in middle of tube with hardened point of triangular file and turpentine. Glue pieces of thin sheet glass on ends. Fill with Bisulphide of Carbon and cover hole with glued paper."

By degrees a spectroscope is entirely built up, and with it the spectra of various metallic vapours are examined till some familiarity is acquired with different spectra. Finally, a polariscope is made and different objects for examination are devised. Our space is more than exhausted, and we cannot follow the teachers further in their work. Time will, no doubt, bring greater experience and improve an already admirable course.

As we remarked in a former article, the good work done by the Department must sooner or later indirectly affect all classes. We trust the time is not far distant when the pressure of public opinion will lead men and women alike to feel but half educated if they have no acquaintance with the living facts and solid ground of nature. The happy results of such a change will soon become apparent. Already, indeed, society is becoming more interested in science. Some knowledge of the methods and results of scientific inquiry is penetrating the population. New habits of thought and modes of reasoning are spreading widely. A juster estimate of the position of the scientific explorer is being held. At the same time a truer knowledge of nature is diffusing more profound and doubtless more reverent conceptions of the orderly mystery that surrounds us.

## CARUS AND GERSTAECKER'S "HANDBUCH DER ZOOLOGIE"

*Handbuch der Zoologie.* Von Jul. Victor Carus und C. E. A. Gerstaecker. (Leipzig: Engelmann.)

THE second volume of this work appeared in 1863, the first part of the first volume in 1868, and at length the book is completed by the appearance of the second part of the first volume in 1875. It is somewhat late in the day to review the earlier parts of the undertaking, but looking at it as a whole, we do not hesitate to say that the "Handbuch" in which Prof. Carus has had the chief share (the Arthropods alone are treated by Prof. Gerstaecker) is eminently useful and worthy of his high reputation for perspicacity and practical good sense. There are few men to whom zoologists both in this country as well as in his fatherland, are so much indebted for solid help in their labours of research or of instruction as to Prof. Victor Carus. Who has not felt grateful to him for the "Bibliotheca Zoologica," which bears his name? What naturalist of this generation has not consulted, as a storehouse of inexhaustible treasure, the "Icones Zootomicæ," which, after twenty years, continues to hold its place as the most valuable pictorial treatise on the Invertebrata which we possess? Prof. Carus has further served his countrymen by acting as the competent translator of Mr. Darwin's works—and to us he has lent timely aid by discharging for two years the duties of the Edinburgh chair of Natural History in the absence of Prof. Wyville Thomson. In an enumeration of the labours of this kind for which zoologists have to thank Prof. Carus, we must not omit the volume on the history of Zoology—published in the Munich series of histories of the sciences—a work which is full of the most interesting details of the early beginnings and strange developments of the study of animal form.

It will not be out of place, whilst strongly recommending this book to the reader as a most trustworthy, succinct, and withal ample exposition of the facts of animal morphology in especial relation to the "system" or classification of the Animal Kingdom—to say a few words as to its method and order of treatment. The first volume (that most recently published) contains the Vertebrata, the Mollusca, and Molluscoidea. The second volume treats of the Arthropoda, Echinodermata, Vermes, Cœlenterata, and Protozoa. The groups of the animal kingdom are thus discussed in a descending order, beginning with the highest: at the same time each section treating of a sub-kingdom is complete in itself. The section of the work treating of any one sub-kingdom starts with a brief definition of the group of some ten or fifteen lines in length. Then follow several pages treating of the characteristic disposition of the various organs and their variation in the following order, (1) general form, (2) integument, (3) muscular system, (4) skeleton, (5) nervous system, (6) organs of sense, (7) digestive canal, (8) respiratory organs, (9) vascular system, (10) urinary and generative organs, (11) development, metamorphoses and reproduction of parts, (12) geographical and geological distribution, (13) chief systems of classification hitherto proposed, with an outline of the classification adopted by the author, brief definitions (about ten lines each) of the classes being introduced. After this we have the detailed consideration of each class, the highest being taken first. The same method is adopted in the exposition of the characters of the class as in the treatment of the sub-kingdom—as much as twenty-four pages being thus devoted to the class Mammalia. To the class follows an enumeration of its orders, each order being *briefly* characterised in the list and then taken in turn, the highest first, for more detailed treatment. Some additional facts with regard to each order beyond those introduced in the brief definition are given when it is thus taken in its turn, and under it are placed in succession with their characteristics briefly stated, the families and sub-families and genera, the enumeration of the latter being *complete.* The principal genera are characterised—referred to their authors whilst synonyms and sub-genera are indicated. The work goes so far into detail as to cite under the genera many of the commoner or more remarkable species—with a statement of the geographical and geological distribution of the genus. After the description of an order or other large group, we usually find a bibliographical list referring the reader to the more important monographs relating to the particular group. Thus the "Handbuch" furnishes us—within the limits which are possible in an ever-growing science—with a treatise on comparative anatomy, combined with an exhaustive enumeration of the genera hitherto distinguished by zoologists, referred to a definite place in a scheme of classification. As the latest complete systematic treatise on the Animal Kingdom, and one executed with the exercise of most conscientious care, and a very exceptional knowledge of the vast variety of zoological publications which now almost daily issue from the press—this work is one which is sure to render eminent service to all zoologists. We can speak to the usefulness of the earlier volume, from an experience of some years, and there is every reason to believe that the one just completed will be found as efficient.

Having said thus much in favour of the "Handbuch," we shall proceed to point out some of its shortcomings, which are rather theoretical than practical. Prof. Carus suffers in this book as in his "History" of Zoology, from the unphilosophic conception of the scope and tendencies of that division of Biology, which its early history has forced upon modern science. In England our newest and most conservative University continues to draw a broad distinction between what is called Comparative Anatomy and what is called Zoology. By some accident Zoology is the term which has become connected with the special work of arranging specimens and naming species which is carried on in great museums, and which has gone on in museums since the days when "objects of natural history," and other curiosities, first attracted serious attention in the sixteenth century. Accordingly Zoology, in this limited sense, has taken the direction indicated by the requirements of the curators of museums, and is supposed to consist in the study of animals not as they are *in toto*, but as they are for the purposes of the species-maker and collector. In this limited Zoology, external characters or the characters of easily preserved parts which on account of their conspicuousness or durability are valuable for the ready discrimination of the various specific forms—have acquired a first place in consideration to which their real significance as evidence of affinity or separation does not entitle them. From time to time the limited zoologists have adopted or accepted from the comparative anatomists hints or conclusions, and have worked them into their schemes of classification. But it does seem to be time in these days, when pretty nearly all persons are agreed that the most natural classification of the Animal Kingdom is that which is the nearest expression of the Animal Pedigree, that systematic works on Zoology should be emancipated from the hereditary tendencies of the old treatises, and should present to us the classes and orders of the Animal Kingdom defined not by the enumeration of easily recognised "marks," but by reference to the deeper and more thorough-going characteristics which indicate blood relationships. We have to note in the "Handbuch" the not unfrequent citation of superficial and insignificant characteristics in the brief diagnoses of taxonomic groups, which seems in so excellent a work to be due to a purposeless survival of the features of a moribund zoology that would know nothing of "insides," and still less of the doctrine of filiation. For instance, the very first thing which we are told of the Vertebrata in the short diagnosis of the group, is that they are "animals with laterally symmetrical, elongated, externally unsegmented bodies;" of the Fishes, that they have the "skin covered with scales or plates, seldom naked;" of the Mollusca, that they have a "laterally symmetrical, compressed body devoid of segmentation, often enclosed in a single (generally spirally-twisted) or double calcareous shell." It would be unjust to suggest that Prof. Carus, who long ago did so much to establish zoological classification on an anatomical basis, is not fully alive to the necessity, at the present day, of taking the wide biological view of animal morphology; but certainly the form in which parts of the book are cast, savours of the past epoch. It may be said that the object of the book is to present the "facts" of Zoology in a logical order; and that this sufficiently explains the arrangements to which objection might be taken as above, viz. the commencing with the higher instead of the lower groups, the prominent position assigned to external and little-significant characters, the absence of any recognition of the leading doctrine of modern Zoology, the doctrine of filiation. To this there is nothing to say excepting that of the very *many* logical methods of treatment possible in a handbook of Zoology, many are easy to follow out, and that one, which aims at presenting a logical classification of the kind spoken of by Mill, in which objects "are arranged in such groups, and those groups in such an order as shall best conduce to the ascertainment and remembrance of their laws," is a very difficult one to follow out. This kind of classification involves nothing less than an attempt (however inadequate) to trace the Animal Pedigree; for the laws to be ascertained and remembered are the laws of Heredity and Adaptation. We may regret then that so able a zoologist as Prof. Carus has remained in the old grooves and not ventured on to the inevitable track where Gegenbaur and Haeckel have preceded him.

It is in the same spirit that we draw attention to one or two features in the logical—or as it is sometimes called "objective"—classification adopted by Prof. Carus. He recognises the Molluscoidea as a main division of the Animal Kingdom, and places in it besides the Brachiopoda and the Bryozoa, the Tunicata. It certainly does not seem likely that in the present year (which is that which gives date to the volume containing the Molluscoidea) he would, if attempting to indicate genealogical affinities in his classification, do what he does whilst working on the old lines, namely, place the Ascidians in association with forms so remote from them as it now appears are the Brachiopods, and separate them so entirely from their blood-relatives among Vertebrates.

It is also interesting to note how the desire to frame symmetrical groups which can be easily defined in a few words, and on the other hand the desire to mark the gaps and the relative development of the branches of the genealogical tree, operate so as to lead individuals influenced respectively by one or other of those desires to propose very different changes in commonly accepted classifications. Both methods may have their use to-day, but we cannot shut our eyes to the fact that the motive in all classifications for the future must be *genealogy*. The changes proposed in J. Müller's classification of Fishes, respectively by Carus and by Haeckel, exhibit well the divergence of the tendencies of the "formal" (we cannot grant them the monopoly of the word "logical") and of the "genealogical" school. Dr. Günther of the British Museum is followed by Prof. Carus in his proposal to reduce Johannes Müller's six sub-classes of Fish, viz. Dipnoi, Teleostei, Ganoidei, Selachii, Cyclostomi, Leptocardii, to four, by the fusion of the Dipnoi, Ganoidei, and Selachii. The discovery of the Australian Ceratodus, which does not possess a special aortic branch distributed to the incipient lungs, and is different from Lepidosiren and Protopterus in the structure of its aortic bulb and its limbs, has been made the occasion for this logical or rather formal simplification. On the other hand, Prof. Haeckel wishing to show the large gap—the long series of intermediate forms—which *must* have intervened between the development of certain of the branches of the pedigree recognised by J. Müller as sub-classes of Fish, and wishing to express the *relative* distance of these branches from one another has, first of all (and we think with no exaggerated estimate of the gap to be marked out), removed the Leptocardii altogether from association with the other fish, and not only from association with them but from association with the remaining classes of Vertebrates. They stand alone as the group Acrania, whilst the remaining Vertebrata are the Craniata. The five remaining groups of Müller's fishes find their place with the Craniata, but one group is separated within that large division as having no jaws, no limbs, and an unpaired nostril; these are the Cyclostomi, which are placed by Haeckel apart from all the remaining Craniate Vertebrates. The steps of structural differentiation which must be passed through to connect the Lampreys with the lowest of the remaining groups of J. Müller's Pisces seems to warrant this. They, the Dipnoi, Ganoidei, Selachii, and Teleostei, all belong to the large division of the double-nostrilled, jaw-bearing Craniata; but Haeckel cannot feel that the logic of his method is fully carried out, if he does not mark more emphatically the divergence of the structural characters of Dipnoi from those of the remaining and dominant classes of Fish. The class of Fishes is restricted to the three sub-classes of Selachii, Ganoidei and Teleostei; of which the first are the nearest representatives of the common ancestors of the Ganoidei and Teleostei, whilst the Dipnoi form a separate class of the Gnathostomous Craniate Vertebrata, reaching well forwards in the direction of the Amphibia, which were derived from Palæozoic Dipnoi, these in turn having been derived from Ganoidei. No doubt, it would not be possible to make any distinction between the ancestral Ganoidei and Dipnoi of Palæozoic times, had we them all before us; but that is no reason why, in framing our classifications, we should not use such breaks and divisions of groups as will best indicate in the tabular form the branching relationships of these and neighbouring organisms. The consideration of a case like the one just discussed renders it very obvious that the whole method and point of view of the naturalist who attempts to make classification the expression of the most important laws of organic structure, and therefore a genealogy, is different from that of the naturalist who endeavours to make his groups as few as may be convenient, and such that a large number of propositions can be affirmed with regard to them. The work of the latter is marred by adhesion to a conventional form, that of the former is inspired by a life-giving theory.

The absence of illustrations to Prof. Carus's "Handbuch" is not to be considered as a deficiency. In the first place, adequate illustration would immensely increase the price of the work; in the second place, we have already the "Icones," which may serve excellently as an atlas for much of the second volume. What we want now from Prof. Carus is another volume of "Icones," to contain illustrations of the Vertebrata.

E. Ray Lankester

## OUR SUMMER MIGRANTS

*Our Summer Migrants.* By J. E. Harting, F.L.S., F.Z.S. (Bickers and Son, 1875.)

Among the many detailed differences between the lives of country and town residents there is one which has a marked influence on the lines of thought adopted by each. The townsman as a rule finds that his numerous avocations—more numerous as they must be to enable him to survive in the severer competition for a livelihood that is associated with the extra expense involved in a non-rural life—give him but little time or need for simple physical exercise as such. He has to form his ideas of the outside world by noting, as he passes through various thoroughfares, such things as attract his attention whilst he is on his way from one duty to another. When his work is over, his great idea is rest. The animated creation, humanity excepted, is a sealed book to him. The case of the country resident is very different. Either his slow-moving occupation in the open air allows him ample opportunity for looking around him, or he is compelled to "take a walk" in order to overcome the injurious influence of a sedentary employment. The charms of scenery soon, from frequent repetition, lose much of their fascination, and the observation of the surrounding changes continually occurring in the animated world become the chief objects of attraction. Of these none are more interesting than the movements of the birds, especially of those species which, instead of taking up their continuous abode with us, only condescend to visit our shores during those seasons of the year which best suit their delicate constitutions. These, our summer migrants, form the subject of the work before us; one which will be particularly attractive, as here presented, to all who have any predilections towards ornithology or the observation of natural phenomena, both on account of the valuable information it contains and the particularly elegant way in which, both typographically and as far as binding is concerned, the book has been brought out, and Bewick's accurate engravings have been reproduced.

Mr. Harting's object has not been to write a systematic work on the subject for beginners, but to collect the results of his own and other more recent observations, both as to the exact dates of arrival and departure of the migratory species of our avifauna, as well as attested facts with reference to the localities which they inhabit as their winter-quarters. Prof. Newton's new edition of "Yarrell's British Birds," Colonel Irby's "Ornithology of the Straits of Gibraltar," and the investigations of the late Mr. Edward Blyth, are amongst the most important sources from which the author is enabled to collect the observations which he classifies and employs so as to make them of special interest with regard to each individual species.

The controversy, not long ago revived, and carried on partly in this journal during 1869 and 1870 by Prof. Newton, concerning the eggs of the Cuckoo, makes the chapter devoted to that bird of special interest. On the subject of whether the hen bird is in the habit of always laying her eggs in nests of the same species of foster parent, Prof. Newton remarks (Nature, vol. i. p. 75), "without attributing any wonderful sagacity to the Cuckoo, it does seem likely that the bird which once successfully deposited her eggs in a Reed Wren's, or a Titlark's nest (as the case may be) when she had an egg to dispose of, and that she should continue her practice from one season to another. We know that year after year the same migratory bird will return to the same locality, and build its nest in almost the same spot. Though the Cuckoo be somewhat of a vagrant, there is no improbability of her being subject to so much regularity of habit, and indeed such has been asserted as an observed fact. If, then, this be so, there is every probability of her offspring inheriting the same habit, and the daughter of a Cuckoo which always placed her egg in a Reed Wren's or a Titlark's nest doing the like." To this Mr. Harting very justly replies—"This would be an excellent argument in support of the theory (of Dr. Baldamus) were it not for one expression, upon which the whole value of the argument seems to me to depend. What is meant by the expression 'Once successfully deposited?' Does the Cuckoo ever revisit a nest in which she has placed an egg and satisfy herself that her offspring is hatched and cared for? If not (and I believe such an event is not usual, if indeed it has ever been known to occur), then nothing has been gained by the selection of a Reed Wren's or Titlark's nest (as the case may be), and the Cuckoo can have no reason for continuing the practice of using the same kind of nest from one season to another." Mr. Harting therefore rejects the application of this principle in the case of the Cuckoo. We will suggest to him a modification of Prof. Newton's argument which may perhaps lead him to return to it in its modified form. The assumption that the bird which once successfully deposited her eggs in a Reed Wren's or Titlark's nest, would again seek for one of the same species in other seasons because of her *sagacity*, or her knowledge of its successful hatching, is highly improbable in our estimamation, and not essential for the subsequent deductions, in a Darwinian point of view. It is more logical to suppose that ancestral Cuckoos deposited their eggs broadcast. That those which got into Reed Wren's and Titlark's nests (as in instances) all, or nearly all, hatched out; whilst those deposited elsewhere perished. The young *inherited* those peculiarities of the mother birds whose tendency was towards the utilisation of the Reed Wren's and Titlark's nests, and as a result the modern Cuckoo tends to place its eggs in those nests.

The evidently genuine sketch made by Mrs. Blackburn of the nestling Cuckoo ejecting the young of the Titlark along with which it was hatched, first published in the introduction to Gould's "Birds of Great Britain," is introduced as confirmatory evidence in favour of this, to the foster-brethren, murderous propensity of the young birds, with reference to which so many naturalists are still sceptical.

The peculiarity in the distribution of the Nightingale in this country is difficult to explain, especially as the Wryneck keeps within nearly the same boundaries. "When we find this bird in summer as far to the westward as Spain and Portugal, and as far to the northward as Sweden, we may well be surprised at its absence from Wales, Ireland, and Scotland; and yet it is the fact that the boundary line, over which it seldom if ever flies, excludes it from Cornwall, West Devon; part of Somerset, Gloucester, and Hereford; the whole of Wales (*a fortiori* from Ireland), part of Shropshire, the whole of Cheshire, Westmoreland, Cumberland, Durham, and Northumberland." From these data it is not difficult to recognise that with but few exceptions the Nightingale only visits those parts of this country which are covered with secondary or tertiary geological formations; and it has always seemed to us that it must be that the primary soils do not produce food suitable for the insects on which it feeds. It is true that the new red sandstone is the soil of Cheshire, and that much of Yorkshire and Derbyshire are primary formations, nevertheless the two boundaries are so similar in other respects that it is hardly possible that there is no relation between them.

There is another disputed point to which the author more than once alludes. He remarks that "we cannot help thinking that the Nightingale and many other birds which visit us in summer and nest with us, must also nest in what we term their winter-quarters; otherwise it would be impossible, considering the immense number which are captured on their first arrival, not only in England, but throughout central and southern Europe, to account for the apparently undiminished forces which reappear in the succeeding spring." The late Mr. Blyth was of an opposite opinion, and further observations are necessary before this question can be settled.

Besides the information given on subjects like the above, the nest and eggs of all the species, fifty in number, are described; whilst exact measurements are included of closely allied forms, such as the Wood Warbler, the Willow Warbler, and the Chiff Chaff; the Red Warbler, the March Warbler, &c. Their plumage and nests are also compared in detail.

To those who reside in the country and are fond of the study of nature, this work by Mr. Harting will be found as useful an addition to their libraries or their drawing-room tables, as it will be to ornithologists generally.

## *OUR BOOK SHELF*

*Meteorology of West Cornwall and Scilly*, 1871 *and* 1874. By W. P. Dymond. (Reprinted from the Annual Reports of the Royal Cornwall Polytechnic Society, Falmouth.)

IN the latter of these pamphlets Mr. Dymond gives an interesting discussion of the temperature range corrections for Falmouth, and an excellent *résumé* of the sea-temperature observations made at the same place during the three years 1872-73-74, which have been made with a just apprehension of the precautions which require to be taken, if observations of sea temperature are to have real scientific value. The omission of tables of daily maximum and minimum atmospheric pressure, which were given in the earlier issue, is a decided improvement; not so, however, is the omission of the table of the amounts of the rainfall, with the different winds, N., N.E., E., &c., which supply information of great value in defining local climates.

The five stations reported on are Scilly, Helston, Falmouth, Truro, and Bodmin, of which the most northern, as well as most elevated, is Bodmin. If we compare the mean temperatures of the stations for 1874, it is seen that at Bodmin the mean was 53°·3, and at Falmouth only 51°·8. In some of the months the discrepancy is still greater. Thus the mean temperature of Bodmin is about four degrees higher than that of Falmouth in each of the months from April to July inclusive, and about two degrees higher than at Truro, Helston, or Scilly. It is unnecessary to remark that these differences do not represent the differences of the climates of these places, but are to a very large extent only due to the incomparable modes of observation and of reduction of the observations adopted for the several stations. Thus, as regards the exposure of the thermometers, at Bodmin they are hung four-and-a-half feet above the ground, under a thatch roof, facing north; at Truro they are placed on the roof of the Royal Institution, about forty feet above the ground, in a wooden shed through which the air passes freely; at Falmouth they are eleven feet above the ground, close to a wall, and in a confined situation; at Helston we are not informed how they are placed; and at the Scilly station we are only told that they "are well placed"—a statement which the observations themselves render very doubtful.

The times of observation are hourly at Falmouth, 9 A.M. and 3 and 9 P.M. at Helston, and as respects the other three stations we have no information. In reducing the observations, "corrections for diurnal range" are used in some cases, though the observations themselves show that the range corrections adopted are plainly not even approximately correct for the place.

A system of meteorological observation which would furnish the data for an inquiry into the important question of a comparison of the local climates of Cornwall requires yet to be instituted. Such a system must secure at each of the stations included within it, uniformity in exposure of instruments, uniformity in hours of observation, and uniformity in methods of reducing the observations. Till this be done, such climatic anomalies, as we have pointed out in the case of Bodmin, will continue to be published, certainly misleading some, and probably leading others to dispute the usefulness of meteorological observations.

We have much pleasure in referring to the additional meteorological information given in the tables, which is often of considerable value, particularly that supplied for Helston by Mr. Moyle, whose tables have the merit of giving the results for the individual hours of observation, as well as deductions from these.

## *LETTERS TO THE EDITOR*

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

### Vibrations of a Liquid in a Cylindrical Vessel

IN NATURE for July 15, there is a short notice of a paper read before the Physical Society by Prof. Guthrie on the period of vibration of water in cylindrical vessels. It may be of interest to point out that the results arrived at by Prof. Guthrie experimentally, and many others of a like nature, may also be obtained from theory.

In the first place the fact, that the period of a given mode of vibration of liquid in a cylindrical vessel of infinite depth and of section always similar to itself (*e.g.* always circular) is proportional to the square root of the linear dimension of the section, follows from the theory of dimensions without any calculation. For the only quantities on which the period $\tau$ could depend are (1) $\rho$ the density of the liquid, (2) $g$ the acceleration of gravity, and (3) the linear dimension $d$. Now as in the case of a common pendulum it is evident that $\tau$ cannot depend upon $\rho$. If the density of the liquid be doubled, the force which act upon it is also doubled, and therefore the motion is the same as before the change. Thus $\tau$, a time, is a function of $d$, a length, and $g$. Since $g$ is $-2$ dimensions in time, $\tau \propto g^{-\frac{1}{2}}$, and therefore in order to be independent of the unit of length, it must vary as $d^{\frac{1}{2}}$ inasmuch as $g$ is of one dimension in length. Hence $\tau \propto d^{\frac{1}{2}} g^{-\frac{1}{2}}$. This reasoning, it will be observed, only applies when the depth may be treated as infinite.

The actual calculation of $\tau$ for any given form of vessel involves, of course, high mathematics, the case of a circular section depending on Bessel's functions. But there is an interesting connection between the problem of the vibration of heavy liquid in a cylindrical vessel of any section and of finite or infinite depth, and that of the vibration of gas in the same vessel, when the motion is in two dimensions only, that is everywhere perpendicular to the generating lines of the cylinder. If $\lambda$ be the wave-length of the vibration in the latter case,* which is a quantity independent of the nature of the gas, and $\kappa = 2\pi \div \lambda$, the period $\tau$ of the similar vibrations in the liquid problem is given by

$$\tau = 2\pi \div \sqrt{gk \frac{(\epsilon^{kl} - \epsilon^{-kl})}{\epsilon^{kl} + \epsilon^{-kl}}},$$

$l$ being the depth. The formula shows that in accordance with Prof. Guthrie's observation $\tau$ diminishes as $l$ increases, and that when $l$ is sufficiently great

$$\tau = 2\pi \div \sqrt{gk}.$$

If $x$ be the value of $k$, viz. $2\pi \div \lambda$, for a circular vessel of radius unity, then the values of $x$ for the various modes of vibration are given in the following table extracted from a paper on Bessel's functions in the *Philosophical Magazine* for November 1872.

| Number of Internal Spherical Nodes. | Order of Harmonic. | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| 0 | 3·832 | 1·841 | 3·054 | 4·201 |
| 1 | 7·015 | 5·332 | 6·705 | 8·015 |
| 2 | 10·174 | 8.536 | 9·965 | 11·344 |

Thus if $d$ be the diameter of the vessel, the period $\tau$ of the liquid vibrations is given by

$$\tau = 2\pi \sqrt{\frac{d}{2gx}};$$

so that if $d$ be measured in inches, the number of vibrations per minute, $n$, is given by

$$n\sqrt{d} = \frac{30}{\pi} \sqrt{24 \times 32{\cdot}19 \times x}.$$

For the symmetrical mode of vibration considered by Prof. Guthrie, $x = 3{\cdot}832$, giving

$$n\sqrt{d} = 519{\cdot}4$$

agreeing closely with the experimental value, viz. 517·5. Even the small difference which exists may perhaps be attributed to the insufficient depth of the vessels employed.

This mode of vibration is not, however, the gravest of which the liquid is capable. That corresponds to $x = 1{\cdot}841$, giving

$$n\sqrt{d} = 360{\cdot}1,$$

and belonging to a vibration in which the liquid is most raised at one end of a certain diameter, and most depressed at the other end. The latter mode of vibration is more easily excited than that experimented on by Prof. Guthrie, but inasmuch as it involves a lateral a motion of the centre of inertia, it is necessary that the vessel be held tight.

The next gravest mode gives $x = 3.054$, and corresponds to a vibration in which the liquid is simultaneously raised at *both* ends of one diameter, and depressed at both ends of the perpendicular diameter. In this case the value of $n$ is given by

$$n\sqrt{d} = 462{\cdot}7$$

Terling Place, Witham, July 15 RAYLEIGH

* Namely, the length of plane waves of the same period.

### Insectivorous Plants

IF further confirmation be needed of Mr. Darwin's discovery of absorption by the leaves of the *Drosera rotundifolia*, it is afforded amply by the following experiments which I have just concluded:—

Having deprived a quantity of silver sand of all organic matter, I placed it in three pots, which I shall call A, B, and C. In each of these pots I placed a number of plants of the *D. rotundifolia* under the following conditions:—(1) Perfectly uninjured, but washed all over repeatedly in distilled water. (2) Similarly washed, but with all the roots pinched off close to the rosette, and with the leaves all buried, only the budding flower stalk appearing above the sand. (3) similarly washed, with the roots and the flower stalk left on, but all the leaves pinched off, the roots being buried in the sand. (4) Similarly washed, roots left on, four leaves buried in the sand, two leaves flower stalk, and roots left above the sand and the roots protected against the possibility of their absorbing anything from the sand. All the plants were carefully watched, so that no flies were caught.

I fed pot A with pure distilled water, B with strong decoction of beef, and C with ·0026 per cent. solution of phosphate of ammonia.

The results are briefly these, after seventeen days' experimentation: In A all the plants are growing and looking perfectly healthy, though those with four leaves buried and the roots exposed, looked sickly for a few days. Now, however, they are putting forth new leaves; so are those with all the leaves pinched off and the roots buried.

Those with the roots pinched off and all the leaves buried are bursting into flower.

In B all the plants are greatly damaged, those with the leaves only, and those with the roots only are quite dead. Those with the roots off and the leaves buried have their leaf stalks much blackened, as described by Mr. Darwin as the result of over-feeding. The pot smells strongly of ammonia.

In C the condition is very much as in A, but the growth has been much more active, for some of the plants with the roots off and leaves buried have pushed new leaves up through the sand, and those with only four leaves buried have put out numerous new leaves, and their roots are quite dry. In one of these latter I amputated the roots five days after it had been in the pot, and it is as vigorous as the rest. About ·03 of a grain of phosphate of ammonia has been supplied to this pot during twelve days for twelve plants.

It is, therefore, perfectly certain that the sun-dew can not only absorb nutriment by its leaves, but that it can actually live by their aid alone, and that it thrives better if supplied with nitrogenous material in small quantities.

The nitrogenous matter is more readily absorbed by the leaves than by the roots, for over-feeding kills the plant sooner by the leaves alone than by the roots alone. But it is also certain that the roots absorb nitrogenous matter.

On June 17 I read a paper to the Birmingham Natural History Society, in which I announced that I had been able to separate a substance closely resembling pepsine from the secretion of the *Drosera dichotoma*. Since then I have also separated it from the fluid taken from the pitchers of various nepenthes.

The secretion from the *Dichotoma* was gathered on a feather which was washed in pure distilled water. It made the water very viscid, although probably the whole amount gathered from the only available plant was not more than six or eight minims, and an ounce of water was used. One cubic centimetre of this solution to five cubic centimetres of fresh milk separated a thick viscid mass, with a very small quantity of whey, in about twelve hours, at the ordinary temperature of the atmosphere. This mixture was kept in an open test glass three weeks, but it never became putrid.

The remainder of the solution was accidulated with dilute phosphoric acid, and then a thin mixture of chalk and water was added drop by drop till effervescence ceased. The mixture was allowed to stand for twenty-four hours and the clear fluid removed.

The precipitate was treated with very dilute hydrochloric acid, and the result treated with a saturated solution of pure cholestearine made by Beneke's method, in a mixture of absolute alcohol and absolute ether. The mass which separated was then dissolved in absolute ether, and in the resulting water was suspended a greyish flocculent matter which, on examination was found to be perfectly amorphous. It was dried at a temperature of 42°, and weighed, roughly, a third of a grain. It was partially soluble in distilled water, not at all in boiling water, greatly soluble in glycerine, and it produced the characteristic viscid change on a small quantity of fresh milk.

Fluid was taken from three nepenthe pitchers which had not opened their valves, to the amount of 2·3 cubic centimetres. It was treated in the same way as described above, and yielded a trace of the flocculent matter. Seven cubic centimetres of fluid from pitchers which had been long open and contained abundant insect *débris*, yielded the same flocculent substance. It has a specific gravity fractionally greater than water, and has reactions quite similar to the substance separated from the *D. dichotoma*, and which I propose to call droserine.

At Mr. Darwin's suggestion I have tried the action of the fluid of four virgin pitchers of the *Nepenthe phyllamphora* on cubes of albumen one millimetre in measurement. After twenty-eight hours immersion there was no indication of change by any one of the four fluids. Yet the chemical differences in all four were very marked. One only was viscid, yet it contained not a trace of the grey flocculent matter which I regard as the ferment. One only was at all acid, the other three being absolutely neutral. One contained quite a large quantity of the ferment, whilst the fourth had no reaction in silver lactate, so that I imagine it was only pure water. On the contrary, fluid taken from pitchers into which flies have previously found their way is always very acid, has a large quantity of the ferment, and acts in a few hours on cubes of albumen, making them first yellow, then transparent, and finally completely dissolving them.

The quantities obtained were too small to submit to analysis, and I am not sufficiently an adept in chemical manipulation to give a better account of this interesting substance.

When studying the nepenthes, I was puzzled to see the use of the channel which exists on the back of the pitchers, and which is formed by two ridges furnished with spikes in most of the nepenthes, but not in all, which run up to the margin of the lip of the pitcher.

I found that one plant under observation was infested by a small red ant-like insect, numbers of which had found their way into one particular pitcher. I observed two or three on the leaf of this pitcher, and I carefully observed their movements. They occasionally approached the edge of the leaf, but always turned back when they encountered the spikes which run down the margin, and which are the same as are seen on the ridges. In all the mature pitchers the stalk hangs in contact with the pitcher just between those two ridges, about half way between the attachment of the stalk and the lip of the pitcher.

At this point of contact the insects marched on to the pitcher, and then, of course, found themselves on the pathway between the ridges. Here they again always turned back when they encountered the spikes, so that they soon found their way to the lip.

Here they paused, and seemed to enjoy some secretion which seems to be poured out on the glazed surface of the lip. Then they travelled onwards, and met the fate of their companions. I found about thirty of these insects in this pitcher, and as they were in various stages of digestion, I presume they were entrapped at different times. I could see no reason why they all went to this pitcher, though no doubt there was one. The secretion in which they were being digested was very viscid and very acid. In the unopened pitcher the secretion is only faintly acid and not at all viscid. The secretion is increased, therefore, as Mr. Darwin has shown to be the case in *Drosera*, in quality after food has been taken in.

The footpath extending from the peticle to the lip of the pitcher, armed on each side with a *chevaux-de-frise*, to prevent the prey wandering off, is a contrivance which is manifestly for the advantage of the plant; so also, is the umbrella which is extended over the orifices of the pitchers in many of the nepenthes. Its obvious use is to prevent dilution of their gastric juice. In some the lid does not cover the orifice; probably there is something special in their habits.

The glands which line the pitchers differ considerably from the *Dionœa*, and they are placed in curious little pockets of epithelial cells, the meaning of which is not evident.

LAWSON TAIT

### Curious Phenomenon in the Eclipse of 1927

ON the morning of June 29, 1927, there will be the next solar eclipse in England in which anything in the shape of totality can be seen. In an examination of eclipses I made two or three years ago, I considered this one would be total for a brief period in the north of England, as mentioned in NATURE, vol. xii. p. 213. But the curious point worthy of notice is the following:—As the moon's disc only just overlaps that of the sun, we may expect to see the red flames visible, not as prominences, but as a line of red light encircling the sun for a few moments. The probable appearance of such a phenomenon in a slightly total eclipse of the sun was pointed out by Prof. Grant in a paper in the December Notices of the R.A.S., 1871 (q.v.) The eclipse of June 29, 1927, seems to afford such an opportunity as the Professor wished to find out. Although this eclipse, therefore, is but an apology for a total one, it may acquire an interest of its own for posterity. See my little work, "Eclipses Past and Future" (Parkers) on this subject. SAMUEL J. JOHNSON

Upton Helions Rectory, Crediton, Devon

### Spectroscopic *prévision* of Rain with a High Barometer

MY letter of last Monday (in last week's NATURE, p. 231) having been sent off when we (in Edinburgh) were still in the midst of heavy rain, N.E. wind, high barometric pressure, and an abnormal sky-spectrum, you may be interested in hearing how matters quieted down until this Monday, when we have a delightful drying west wind, high floating clouds, and a normal sky-spectrum showing fine lines only.

On Tuesday the 20th then, there was a sensible alleviation of Monday's abnormal spectrum bands, though they were still there; and the weather, though dark, began to clear.

On the 21st and 22nd, the abnormal bands had almost disappeared, leaving the lines proper of the spectrum easily visible, and the weather was fine.

Friday, the 23rd, however, was wet by day and very wet at night; yet the sky-spectrum was good and nearly normal. Note, however, from the Meteorological Journal below,* that this rain came with a west wind, a low barometer, and a considerable fall of temperature. And the wind has been westerly ever since, and with a normal sky-spectrum.

Hence the intensification of the band on the less refrangible side of D would seem to be thus far identifiable both in London and Edinburgh with warm rain in an easterly wind and under a high barometer.

While, that the said band really was intensified to a very noteworthy degree, and quite abnormally both with respect to the broader band which appears on the *more* refrangible side of D (or over W.L.L. 5830—5680), and to other telluric manifestations, at sunset—is demonstrated now most satisfactorily by my having just heard from my friend, Prof. P. G. Tait, M.A., whom I had not seen for six weeks before, that he has been independently observing in Edinburgh the very same phenomenon, and almost at the same times, and on the same days. He was much struck too at obtaining the chief abnormal band on the most marked days from *all* parts of the sky and at all hours, and had considered what it might mean.

He has further pointed out to me since then, that Angstrom's map shows fine telluric lines in the place of the grand smoky band we observed with small spectroscopic power in W.L.L. 6000–5880; but makes them much less, instead of very much more, dark than the well-known 5830–5680 evening band; so that the question now is, what is it that *intensifies* the former and not the latter under the meteorological conditions noted?

15 Royal Terrace, Edinburgh, July 26 — PIAZZI SMYTH, Astronomer Royal for Scotland

### Sea-power

I OBSERVE that a correspondent at Giessen asks (NATURE, vol. xii. p. 212) for information as to Sea-power. If he will consult Sir Robert Kane's "Industrial Resources of Ireland" he will find what he wants, with a view to what have been termed "tidal mills."

Edinburgh, July 26 — A. C.

## OUR BOTANICAL COLUMN

THE ADELAIDE BOTANIC GARDEN.—From Dr. Schomburgk's Report on the progress and condition of the Adelaide Botanic Garden and Government Plantations during the year 1874, we gather some facts relating not only to the capabilities of the Garden in an educational point of view, but also with regard to the acclimatisation of new plants, many of which are valuable for their economical products, and others as horticultural novelties. In what is called the class ground 130 natural orders are represented and 750 genera. The plan adopted seems to be similar to that adopted in most botanic gardens, namely, by dividing the orders by strips of turf; the aquatic plants, such as the Nymphæaceæ, Vallisneriæ, Butomaceæ, Alismaceæ, &c., are arranged in a basin in the centre. Dr. Schomburgk points out what is apparent to all botanical students, that it is almost an impossibility to lay out a systematic ground perfectly, as the representatives of some orders are composed partly of natives of cool and partly of tropical countries, while other orders are solely tropical plants: the same difficulty also occurs in the lower orders of plants, such as Cryptogams. As Dr. Schomburgk says, it is to be hoped that this comparatively new feature in the plan of the Adelaide Garden will be useful to the students at the University, the foundation of which we are told is now a fact, and so promote the study of botany in South Australia. In the experimental garden great success seems to have been attained in growing the Tussack grass (*Dactylis cæspitosa*). As is well known, this plant forms a most nutritious fodder; and it is thought that if it succeeds, it will prove a most valuable acquisition to the scanty stock of good Australian fodder plants. The seed was received in Adelaide in September last, and upon being at once sown soon made its appearance above ground: the quickness of growth is said to be surprising; many of the plants in 4-inch pots showed, at the time of writing the report at the latter end of February, seventy to eighty shoots. About a dozen plants were put out in 6-inch pots, and these in the same period had as many as 123 shoots, the blades of which were remarkably sweet and soft and of a good flavour. Dr. Schomburgk says that he is convinced, though the native countries of the Tussack are much colder than Australia, it will do well in the hills; he has about 1,000 plants in pots, which are naturally sheltered part of the day from the sun, and are also watered; many of the plants are during the day more or less exposed to the sun, but he has observed no difference in their growth. It is remarkable that, notwithstanding all the pains that have been taken, both at home and in Australia, to introduce many of these useful grasses, little or no interest seems to be taken by the colonists themselves in the matter for whose benefit they are specially undertaken.

The Liberian Coffee, about which so much has been said and so much more is expected, has likewise found its way to Adelaide, four healthy plants having been received from Mr. Bull, of Chelsea. Among other economic plants recommended by Dr. Schomburgk for trial in South Australia may be mentioned the Liquorice (*Glycyrrhiza glabra*).

SUMBUL ROOT, the tincture of which is now so frequently prescribed as a stimulating tonic, had, previous to the discovery of the plant in 1869, a peculiar mystery attached to it regarding its origin, and this mystery was all the more intense from the fact that in commerce dealers distinguished Sumbul by two or three different qualities, each of which was said to be derived from different countries. Thus, the best kind was distinctly known as Russian Sumbul, and the second quality as Indian Sumbul, a variety or form of which was also known as China Sumbul, being shipped to England *viâ* China, while the Indian kind is brought from Bombay. Of the plant furnishing this Indian or Chinese product we know nothing. The root is described by Pereira in his "Elements of Materia Medica" as being of a closer texture, firmer, denser, and of a more reddish tint than the Russian sort, and of a less powerful odour. The authors of the "Pharmacographia," however, consider it "to be a root different from Sumbul," that is, the true or Russian Sumbul. The mystery regarding the botanical origin of this latter has within the last few years been cleared up by the discovery, in 1869, of living plants in the mountains near Pianjakent, a Russian town eastward of Samarcand. The Botanic Garden at Moscow was fortunate enough to receive a living plant which flowered in 1871, and was thereupon named by Kauffmann *Euryangium Sumbul*. A plant was introduced to the Royal Gardens, Kew, some two or three years since, and planted in the open ground, where it has flourished through the summer, throwing up its strong, bright green *Ferula*-like leaves, and dying down to the earth in winter, during which period it has received artificial protection. Up to the present season the plant has never flowered, but recently it has thrown up a strong and healthy umbel, some seven or eight feet high. It is only in quite recent times (1867) that the Sumbul has been admitted into the British Pharmacopœia. In the first edition, which was issued in 1864, it was not included. It has now become largely used, and its application is still increasing, being frequently administered in cases where quinine is too powerful. The root is of a soft spongy nature, with numerous interlacing fibres; it has a bitter aromatic taste, and a strong musk-like smell which it is capable of retaining for a great length of time, the specimens contained in the Kew Museum, where they have been for the last twenty-four years, retaining still the odour in a marked degree.

* *Meteorological Journal at* 1 P.M. *Royal Observatory, Edinburgh.*

| Date. | Barometer reduced to sea-level. | Attached Thermometer. | Exterior Thermometer, in shade. | Direction of wind. |
|---|---|---|---|---|
| 1875. | inches. | ° F. | ° F. | |
| July 20 ...... | 30·08 | 60·0 | 61·5 | N.E. |
| " 21 ...... | 30·01 | 62·2 | 64·7 | N.E. |
| " 22 ...... | 29·74 | 63·5 | 68·1 | N.E. |
| " 23 ...... | 29·58 | 61·8 | 58·9 | W. |
| " 24 ...... | 29·49 | 57·4 | 57·6 | W. |
| " 25 ...... | — | — | — | — |
| " 26 ...... | 30·24 | 58·0 | 60·3 | W. |

## THE PROGRESS OF THE TELEGRAPH *

### IX.

In all submarine cables the copper conductor is composed of seven small wires stranded together, an arrangement which gives much greater flexibility and strength than if a solid wire were employed. The general arrangement of the signal apparatus in connection with the cable is shown at Fig. 38. A, the battery, consists of a series of cells of Daniell's arrangement; B, the contact keys for passing the positive and negative currents into the cable; C, "switch," placing the cable in connection either with the earth, instrument, or battery as required; D, a form of Sir William Thomson's reflecting galvanometer placed in connection with the cable by switch C; E, the permanent magnet arrangement for steadying and adjusting the coil-mirror (shown in section and detail, Fig. 39); I, resistance coils interposed into the circuit

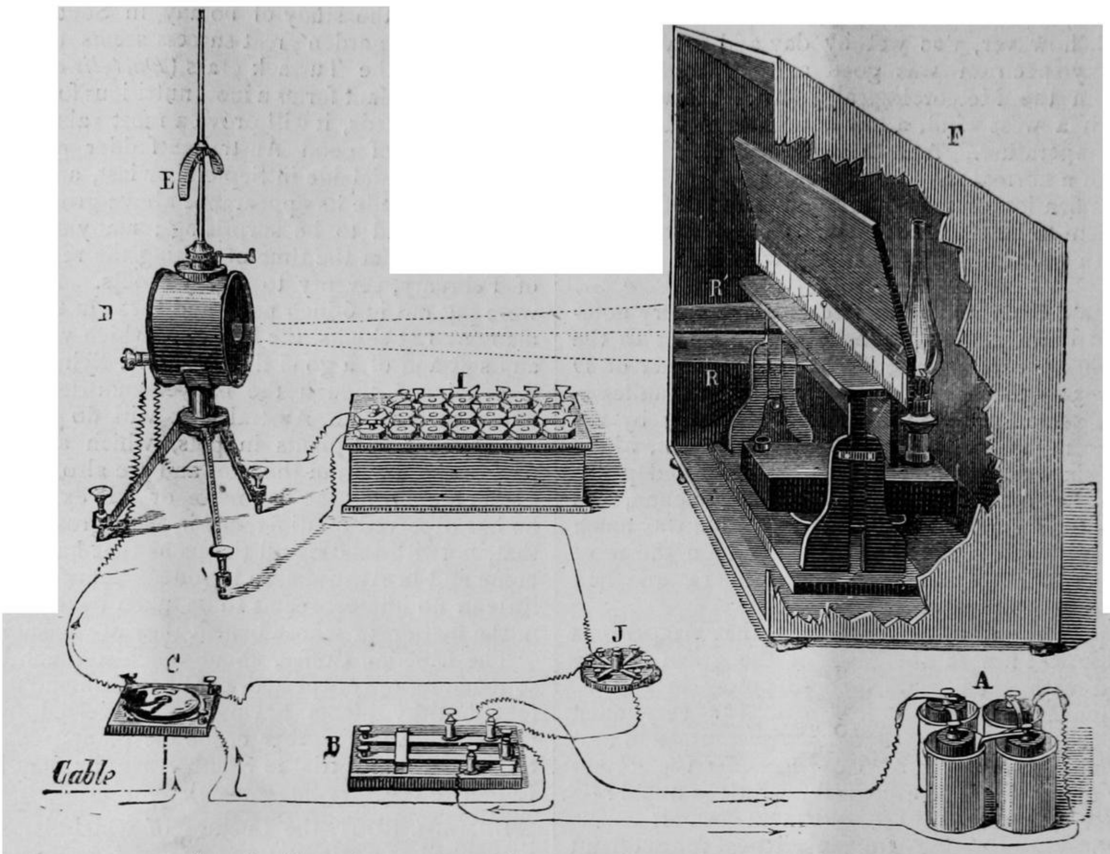


FIG. 38.—General arrangement of apparatus for working a submarine circuit.

between the instrument and the earth; J, a switch for connecting the line to earth; F, a darkened recess to receive the scale upon which the spot of light reflected from the lamp situated behind the partition, the ray from which, passing through a slit in the direction R is reflected back from the galvanometer mirror in the direction R′; the spot of light moves to the right or left of the zero on the scale, according as a positive or negative current is passed through the circuit; the several signals being indicated by the successive oscillations of the luminous image, signals which correspond to the conventional alphabet of the Morse system. The Morse alphabet is given at Fig. 40.

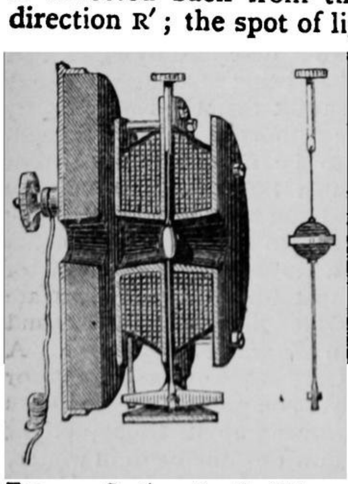

FIG 39.—Section of coil of Thomson's mirror galvanometer, showing the mirror and magnetic needle suspension.

A steam-engine without the motive power, steam, is nothing but an arrangement of iron levers, cranks, and throttle valves, useless so far as actual work is concerned. In like manner a telegraph instrument without the electric current to actuate its parts and give vitality to the circuit is valueless—a piece of apparatus to be inspected on a museum shelf. A few remarks upon "Batteries" are therefore necessary before an examination is made into the chief laws which regulate the passage of electric currents through metallic conductors.

* Continued from p. 151.

In the production of a galvanic, or voltaic current, two conditions are essential, either the presence of two metals and a liquid, or two liquids and a metal. This will be explained by reference to everyday phenomena.

| | | | |
|---|---|---|---|
| a | · — | o | — — — |
| ä | · — · — | ö | — — — · |
| b | — · · · | p | · — — · |
| c | — · — · | q | — — · — |
| d | — · · | r | · — · |
| e | · | s | · · · |
| é | · · — · · | t | — |
| f | · · — · | u | · · — |
| g | — — · | ü | · · — — |
| h | · · · · | v | · · · — |
| i | · · | w | · — — |
| j | · — — — | x | — · · — |
| k | — · — | y | — · — — |
| l | · — · · | z | — — · · |
| m | — — | ch | — — — — |
| n | — · | | |

FIG. 40.—The Morse Alphabetical Code.

A familiar example of the development of an electric current by two metals and a liquid is continually presented to our notice in the wasting of the iron bars of a railing close to their junction with the stone coping. Here we have the two metals, the iron composing the railing, and the lead by which the iron is fastened into the stone, and rain or atmospheric moisture, as the liquid or exciting medium. The wasting away of the iron just above the coping stone is the result of the galvanic action set up between the two metals (iron and lead) and the liquid (the moisture of the atmosphere). To preserve an iron railing therefore it becomes necessary to dispense with the presence of lead; nothing can be better than the adoption of an iron coping in place of stone. As knowledge spreads, so practical results follow, and many modern examples of iron railings will be found to fulfil the conditions above indicated as necessary to ensure a "long life."

All connoisseurs of malt and hop beverages agree that ale drinks much sharper and is more tasty to the palate out of a pewter tankard than out of a glass. At a refreshment bar the demand is more often for "half a pint of bitter" (served in a metal vessel) than for a "glass of bitter;" and common belief in this instance is correct. Here we have a galvanic current set up by two liquids and one metal; the effect of the electric current so generated being to sharpen and improve the taste of the beverage to the palate by reason of electric action. In this example there are the two liquids—the beverage, and the saliva of the mouth—and one metal—that of the tankard—the resultant effect on the palate of the consumer being an increased life or vigour in the taste of the beverage. Thus, even in the trivialities of everyday life, electricity has a part to play. The generation of the voltaic current for telegraphic purposes is based upon one or other of these principles; and it is essential in telegraphy that the power of the current derived from the battery should be adjusted to the circuit.

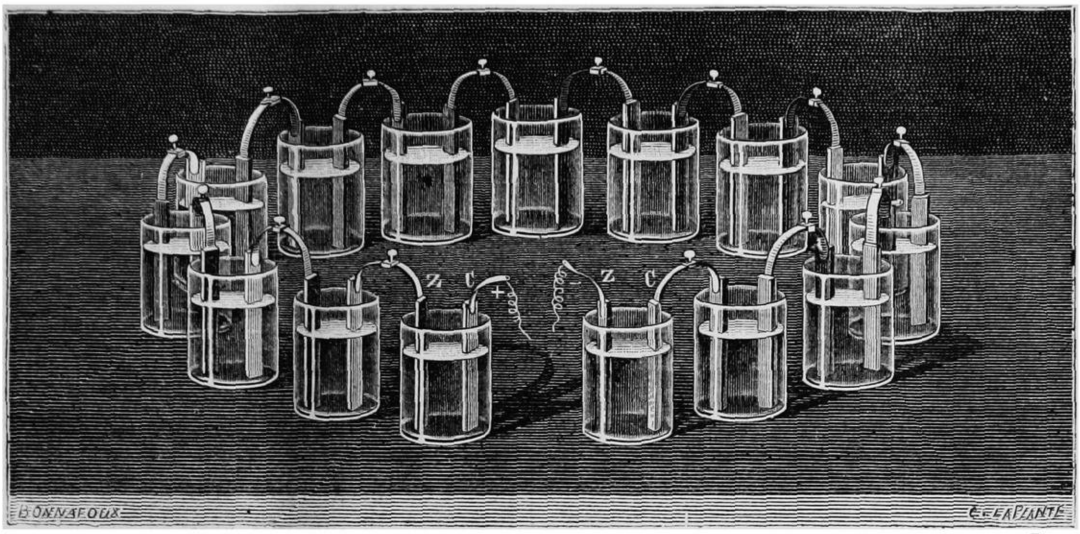


Fig. 41.—Voltaic Battery connected in series, in illustration of the *internal resistance* of the battery.

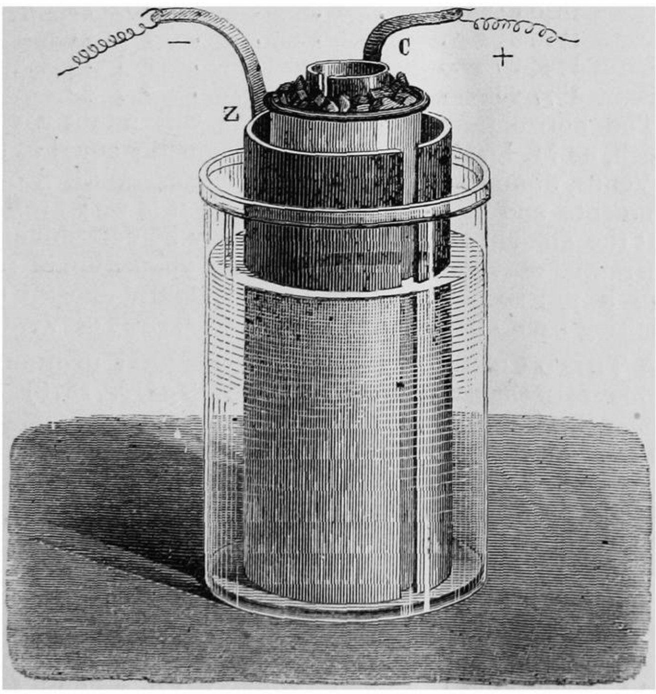


FIG. 42.—The Daniell Battery.

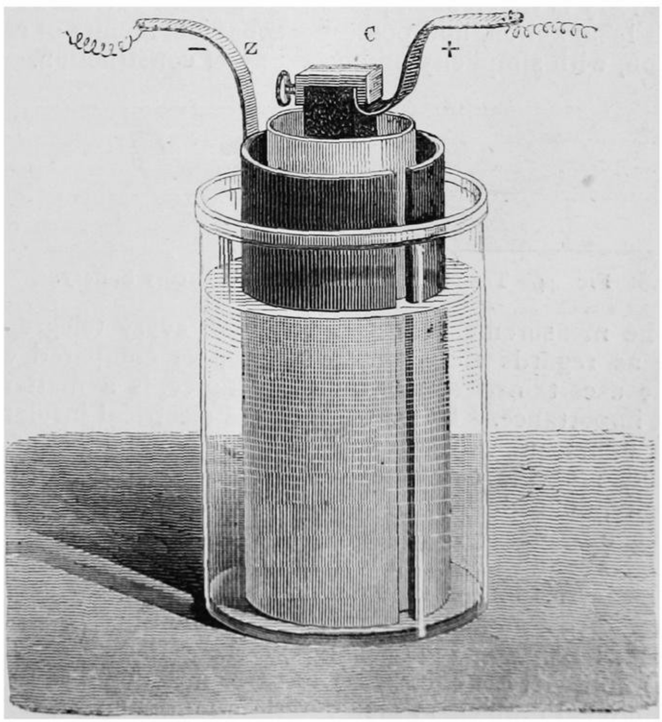


FIG. 43.—The Bunsen Battery.

The strength of the current depends on the *electro-motive force* of the battery and upon the *resistance* of the circuit. The precise meaning to be attached to these terms was first pointed out by Ohm in 1827, who showed that the strength of the current is directly proportional to the former and inversely proportional to the latter. The statement of this relation is commonly spoken of as "Ohm's Law." The total resistance of a telegraphic circuit is made up partly of the resistance of the *battery*, and its necessary connections, and partly of the resistance of the metallic conductor constituting the *line*. Consequently the law established by Ohm may be expressed as follows:—

The available effective force of any current = the electromotive force of the Battery ÷ (the resistance of the Battery + the resistance of the line wire).

It has been found that in any given case the electromotive force and resistance depend upon conditions that may be thus stated:—

First, "*The electromotive force* of a voltaic circuit varies with the number of the elements, and the nature of the metals and liquids which constitute each element, but is in no degree dependent on the dimensions of any of their parts." Second, "*The resistance* of each element is directly proportional to the distances of the plates from each other in the liquid, and to the specific resistance of the liquid; and is also inversely proportional to the surface of the plates in contact with the liquids." Third, "*The resistance of the connecting wire of the circuit* is directly proportional to its length and to its specific resistance, and inversely proportional to its section." Some of the more important forms of battery in use will now be described.

Daniell's Battery, Fig. 42, consists of an earthenware or glass vessel, within which a smaller jar of some porous material is placed; the space between the inner and outer jars is filled with a dilute solution of sulphuric acid and water, and within the porous jar a saturated solution of sulphate of copper; a cylinder of zinc is immersed in the acid solution, and a cylinder of copper in the sulphate solution, crystals of sulphate of copper being introduced to maintain the strength of the copper medium. The current from this battery is remarkably constant, a matter of the greatest importance in the working of a telegraphic circuit, as with a variation in the working strength of the current, continued adjustment of the transmitting and recording apparatus is rendered necessary. Bunsen's battery (Fig. 43) in many respects resembles the Daniell arrangement; carbon is used within the porous cell in place of the copper cylinder, and nitric acid replaces the saturated solution of sulphate of copper. The current produced is stronger, but less constant than that from the Daniell's cell.

Many other arrangements for the generation of a voltaic current for telegraphic purposes are in use, such as the "Marié Davy" (Fig. 44), the "Leclanché," and "Callaud" batteries; more or less, each has its special merits and demerits: practically, the "Daniell" remains unsurpassed. The essential condition of every practical form of battery is that it shall produce a constant current be free from local action, and possess mechanical facility of renovation, with simplicity and economy of construction.

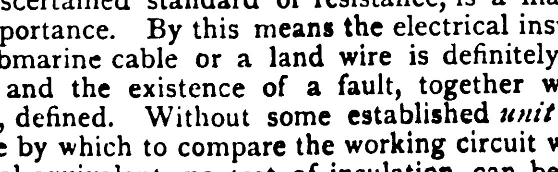

FIG. 44.—The Marié Davy sulphate of mercury Battery.

The measurement of the value of every telegraphic line as regards electrical resistance, as compared with some ascertained standard of resistance, is a matter of vast importance. By this means the electrical insulation of a submarine cable or a land wire is definitely ascertained, and the existence of a fault, together with its locality, defined. Without some established *unit* of resistance by which to compare the working circuit with its electrical equivalent, no test of insulation can be maintained or restoration of a circuit carried out. By general acceptance a standard of measurement has been adopted, a unit of resistance known as the B.A. (British Association) unit. It is unnecessary to enter into detail as to the mechanical problems which determine this unit of resistance; it is sufficient to state that the electrical resistance or value of every circuit, land wire and submarine cable, is now by universal acceptance recorded in B.A. units. For instance, a guttapercha submarine cable core may be stated to be so many hundred millions B.A. units of insulation test; while, again, an indiarubber core may be stated to be so many thousand millions of B.A. units of resistance; a correct comparison is thus at once determined.

(*To be continued.*)

## OUR ASTRONOMICAL COLUMN

THE TRANSIT OF VENUS, 1882 DECEMBER 6.—The Greenwich time of first *internal* contact in this transit at any point in these islands, according to Leverrier's Tables of Sun and Planet, may be accurately found by the following equation, in which $l$ is the geocentric latitude of the place, $\rho$ the corresponding radius of the earth, and L the longitude, reckoned positive, if east of Greenwich, and negative, if west:—

$$\text{G.M.T. first Int. Cont.} = \text{Dec. 6d. 2h. 16m. 16s.} + [2{\cdot}5855]\,\rho \sin l - [2{\cdot}4774]\,\rho \cos l \cos (\text{L} - 85^\circ\, 58'{\cdot}6)$$

The quantities within square brackets are logarithms; the correction of course results in seconds. Direct computations for Greenwich, Edinburgh, and Dublin, furnish the following particulars of the first internal contact at these places:—

| | Local Time. | Angle from N. point. | Angle from Vertex. | Sun's Altitude. |
|---|---|---|---|---|
| | d. h. m. s. | ° ′ | ° ′ | ° |
| Greenwich ... | Dec. 6 2 21 2 ... | 150 40 ... | 128 2 ... | 9·2 |
| Edinburgh ... | „ 2 8 46 ... | 150 42 ... | 132 8 ... | 6·5 |
| Dublin ... | „ 1 56 8 ... | 150 41 ... | 132 24 ... | 9·6 |

At Greenwich the sun sets just one hour and a half after Venus has wholly entered upon the sun's disc.

THE SUN'S PARALLAX.—M. Liais, Director of the Imperial Observatory of Rio de Janeiro, has intimated his intention to make a serious attempt to determine this important element from the very favourable opposition of the planet Mars, which will occur early in September 1877, being encouraged thereto by the success which attended his observations about the opposition of 1860, when his instrumental appliances were very inferior to what they are likely to be in 1877. The planet arrives at perihelion on the 21st of August in that year, and in opposition at midnight on the 5th of September; it is in perigee on September 2nd at a distance of only 0·3767, which is not far from the minimum, though slightly greater than in the last three repetitions of the 79-year period, as will appear from the following comparison:—

| Opposition. | Mars—Mean Anomaly. |
|---|---|
| 1640·64 | − 0° 12′ |
| 1719·65 | + 2 31 |
| 1798·66 | + 5 15 |
| 1877·68 | + 7 58 |

The horizontal parallax of Mars will attain a value which, as M. Liais remarks, will be sensibly equal to that of Venus, diminished by that of the sun. With firm instruments and experienced observers, it is very probable that the amount of solar parallax may be determined by differential observations of Mars at the opposition of 1877, with a precision which may be comparable with that resulting from observations of a single transit of Venus.

A THIRD COMET IN 1813 (?).—Bode, after mentioning in his Miscellaneous Notices (*Berl. Jahrb.* 1818) that Canon Stark of Augsburg had observed the first comet of 1813 on the 19th of February, states that Stark had also discovered on the same evening with a 3½ feet Dollond telescope, a very small and exceedingly faint comet without tail above the variable star Mira in Cetus, the position of which, by comparison with the variable, he found to be at 7h. 28m. 37s., in R.A. 31° 17′ 23″, and Decl. 1° 52′ 9″ S. He saw the comet a second time on the 20th, and again comparing it with Mira, and another adjacent star, its place at 7h. 32m. 13s. was in R.A. 33° 47′ 3″, and Decl. 5° 49′ 7″ S. Cloudy skies are said to have prevented further observation. Bode remarks, with respect to this comet, that it is strange that no other astronomer had perceived it, "doch versichert Herr Stark," he adds, "noch in seinem letzten Schreiben an mich, aufs Heiligste, die Richtigkeit dieser Wahrnehmung." However suspicious this circumstance may have appeared, we know that several of the comets of short period have been revolving in such orbits for one or two centuries, visiting these parts of space without doubt under favourable circumstances for observation on more than one occasion, yet entirely escaping detection, so that the mere fact of a single observer only having seen a comet, is hardly a sufficient argument against its existence. The late Prof. d'Arrest even thought it worth while to submit the reputed observations of the D'Angos-Comet of 1784 to further calculation, notwithstanding Encke's well-known investigation in the "Correspondance Astronomique" of the Baron de Zach, and we may have something to say on this subject in a future column. Not having seen any reference to "Stark's comet" in English astronomical works, we have given the particulars recorded of it here.

THE GREAT COMET OF 1843.—There was some doubt at the time, from the difficulty attending the determination of the orbit of this extraordinary body upon the European observations, whether it had transited the sun's disc on the day of perihelion or not. The definitive orbit calculated by a most complete investigation by the late Prof. Hubbard, of Washington, shows that a transit did actually take place on the evening of February 27, Greenwich time, and might have been observed in Australia. In next week's "Astronomical Column" we shall give the particulars of this interesting phenomenon, and reproduce Hubbard's elements with some inferences drawn from them.

D'ARREST'S COMET IN 1877.—The mean motion of this comet at the last appearance in 1870, determined by M. Leveau from an elaborate calculation of the perturbations in the two preceding revolutions, would bring this comet into perihelion again on April 17, 1877. The effect of planetary attraction in the present revolution being comparatively small, if we take this date for perihelion passage, the computed path is not likely to differ materially from the true one. It is as follows :—

| Obs. Greenwich. | R.A. h. m. | N.P.D. ° | Distance. from Earth. |
|---|---|---|---|
| 1877 March 8 | 20 51 | 100·6 | 2·03 |
| ,, 28 | 22 6 | 97·2 | 1·94 |
| April 17 | 23 16 | 93·2 | 1·89 |
| May 7 | 0 25 | 89·2 | 1·89 |
| ,, 27 | 1 30 | 85·7 | 1·90 |

It would appear from this track that the only chances of observation will be with the aid of powerful telescopes in the southern hemisphere. At the last return the comet was excessively faint, and was only detected at a few of the European observatories.

## *THE INTERNATIONAL GEOGRAPHICAL EXHIBITION*

THE idea of holding an International Geographical Exhibition at Paris, the opening of which we announced last week, in connection with the Geographical Congress which opens in a day or two, was a happy one, and has so far been fruitful in results. The catalogue of articles exhibited covers about 450 octavo pages, and the daily number of visitors reaches thousands; last Sunday it was 12,000, including the Sultan of Zanzibar, and other visitors of all ranks and classes of society. No better method could have been adopted of showing the advances made in geography in recent years; how from being a mere record of "hairbreadth 'scapes by flood and field," it has become a complicated science, or rather meeting-ground of all the sciences; for, as the equipment of and instructions to the English Arctic Expedition show, it requires the aid of all the sciences to do its work well, and in return carries contributions back to them all. We have no doubt that the great majority of the visitors to the Exhibition will be astonished that geography has so many and so varied apparatus and results to show, and we hope that the Exhibition and Congress will be the means of awakening in France, as well as in other countries, an increased interest in geography, lead to its being raised to a higher platform in education, and to its being taught in a more comprehensive and more scientific way than hitherto. No doubt this will be but the first of a series of such exhibitions and congresses, though probably not annual, and we hope that the next one will be held in London. We think they are well calculated to give a strong stimulus to the scientific study of geography.

The arrangements of the Paris Exhibition make it accessible to all classes, the price of admission in some cases being as low as a penny. The articles are arranged mainly according to countries, Britain occupying but a comparatively narrow space in the catalogue. While Russia has 42 pages, Sweden, Norway, and Denmark about 40, Holland 30, Austria and Hungary 44, Great Britain and her Colonies cover only 9 pages. Even Germany has only 12 pages allotted to her. These apparent anomalies no doubt arise from some imperfections in the preliminary arrangements, and are probably to be looked for in first attempts of this kind; no doubt the organisers of the next Geographical Exhibition will profit by the defects of the present, and have one complete all round.

As our readers are aware, the objects exhibited are classified into seven groups; an indication of what is included in each group will convey some idea of the nature of the objects exhibited, as well as of the comprehensive nature of modern geography.

Group I., Mathematical Geography, Geodesy, and Topography, includes of course instruments of practical geometry, surveying, topography, geodesy and astronomy; tables of projection and calculation, maps according to the various systems of projection, sidereal maps, maps of triangulation, maps showing the curves of magnetic declination, &c. In the second group, that of Hydrography and Maritime Geography, is included a great variety of instruments besides those used on board all sea-going ships; there are dredging and sounding apparatus with specimens of what is brought up from the sea-bottom, sounding thermometers and charts, and publications of various kinds. The third group is an interesting one; it includes Physical Geography, General Meteorology, General Geology, Botanical and Geological Geography, and General Anthropology. These are illustrated by instruments used in the observation of the principal meteorological phenomena, by maps, atlases and globes representing the essential facts belonging to the domain of Physical Geography, Meteorology, and the other sciences referred to, as well as publications bearing upon them. In group IV., that of Historical Geography, History of Geography, Ethnography, and Philology, are included, works and MSS., ancient and modern, bearing on these subjects, ancient globes and maps, antiquated instruments, ethnographic collections, and dictionaries of geography.

As might be expected, the fifth group, Economic, Commercial, and Statistical Geography is a large and varied one; it includes works and maps bearing on population, agriculture, industry, commerce, ways of communication, ports, colonisation, emigration, &c., plans and models of bridges, tunnels, railways, routes, telegraph lines; new apparatus for piercing rocks, manufactures or mineral objects peculiar to any country, collections of all kinds of commercial products, machinery used in manufactures of such products, produce and apparatus of deep-sea fishing, &c. Group VI., Education and the Diffusion of Geography, includes of course works, maps, charts, globes, models and instruments of various kinds, and deserves the attention of all engaged in education. Group VII. comprehends Explorations, Scientific, Commercial, and Picturesque Voyages, and, as might be expected, includes a great variety of objects. There are astronomical, topographical, meteorological, and photographic instruments of various kinds; collections of every kind bearing on voyages of exploration, including cooking apparatus and drugs; native implements and weapons; tents and boats of various kinds, special instruments and apparatus for polar expeditions, &c., not to mention narratives and publications of every kind relating to voyages.

How varied the programme of this exhibition is will be seen from the above, as well as the fact that the geography of the present day is a very complicated and all-embracing province of knowledge indeed.

It is impossible here to analyse in detail the exhibits of each country; we can only at present refer to some of the objects which, as we learn from a correspondent, have attracted considerable attention.

The fine set of instruments for travellers exhibited by our Royal Geographical Society, and invented by Capt. Georges, R.N., seems to have excited considerable attention; it includes a double pocket sextant, an artificial horizon, and a barometer; the latter especially, on account of its ingenious construction, making it useful in mountaineering, is said to have attracted the attention of the New French Alpine Club.

From Norway comes a very simple declimeter having a crank working on a small notched wheel which multiplies by ten the number of degrees on the limb on which the readings are taken; a close approximation can thus be obtained by a very simple contrivance.

A Russian marine officer has sent a compass magnificently fitted up, and a lead for taking soundings, and samples of the bottom in lakes and shallow seas. It was used with success on Ladoga, the Caspian, and the Baltic. The apparatus is very simple, cheap, and not ponderous.

Mohn's map of churches struck by lightning in Norway is exhibited in order to illustrate the special danger of lightning to churches. It shows that two churches in every three years are struck and one of the two is utterly destroyed, and that in a climate where thunderstorms are relatively infrequent.

Sweden exhibits two wonderful pieces of apparatus. The first is a meteorograph for printing in numbers the degrees of dry and wet bulb thermometer, barometer, and the force of the wind. The types are placed on wheels which are moved every quarter of an hour by electricity. The barometer is a syphon one, and the thermometers open by the top a needle which descends every quarter of an hour into the mercury and gives the degree. The apparatus works regularly at the University of Upsal and at the Vienna Observatory, where the readings have been found quite correct. The printed sheets obtained at Upsal are posted on the wall of the Geographical Exhibition.

A Swedish engineer has invented a machine to show where to find beds of iron ore, and to determine also the depth to which it is necessary to descend. The miracle is performed by tracing on a map isodynamic magnetic curves, with a compass exposed to the perturbating influence of a magnetic needle placed at a distance. Two systems of isodynamic curves are to be traced, and the distance between both centres is proved to indicate the depth. Experiments and explorations with this extraordinary instrument have proved successful.

The Belgian universal meteorograph, as used in Ghent, is said to be the great success of the Exhibition. It is expected to create a revolution in weather-warnings and in meteorology generally, and will leave the famous Greenwich registering apparatus far behind. A reading is taken every quarter of an hour and engraved on copper ready for going through the press. The inventor is M. Van Rysselberghe, Professor to the Navigation School of Ostend.

The members of the several juries visited the galleries of the Exhibition on Monday last for the first time. Many members of the Academy of Science—MM. Leverrier, Faye, Quatrefages, and others—were present, as well as the foreign commissioners. We hope to give further details next week.

## *THE REGULATION OF RIVERS*

THE recent disastrous floods in France and England call attention to the question whether it is practicable so to regulate the flow of the water in rivers as to prevent, or at least greatly diminish, such misfortunes for the future. Facts and numerical data exist which show that such regulation is practicable with much less difficulty and cost than would be thought by any one who had not made the necessary calculations.

It is perhaps scarcely necessary to say that the method of keeping the floods off the lands by means of embankments, which is the only possible resource when we have to contend against the sea or tidal rivers, is totally inapplicable to the case of the inundations of mountain streams like the Garonne. There need not be any difficulty as to the strength of the embankments, but it would be impracticable to make them high enough to contain between them such torrents as that of the Garonne when in flood. The only way in which mountain torrents can be regulated is by constructing reservoirs to retain the flood-water: and the more this plan is looked at, the more feasible it will appear.

We shall first refer to a paper by Charles Ellett, jun., C.E., on "the Physical Geography of the Mississippi Valley, with suggestions for the improvement of the navigation of the Ohio and other Rivers," forming part of the "Smithsonian Contributions to knowledge" for 1851, published by the Smithsonian Institution, Washington.

This paper contains the tabulated results of an elaborate series of observations made by the author in the spring and summer of 1849 on the flow of the Ohio, at Wheeling, between Pittsburg and Cincinnati. The flow varied from 10,158,000 cubic feet per hour, with a depth of 2.20 feet on the bar at Wheeling, to 736,000,000 cubic feet, with a depth of 31·25 feet on the bar.

"The average volume of water annually flowing down the Ohio is 835,000,000,000 (eight hundred and thirty-five thousand million) cubic feet. This volume would fill a lake 100 feet deep and $17\frac{1}{3}$ miles square. To have regulated the supply of the river in 1848, so as to have kept the depth on the bar at Wheeling uniform throughout the year, would have required reservoirs capable of holding 240,000,000,000 cubic feet, which is equivalent to a single lake 100 feet deep, and $9\frac{1}{8}$ miles square. There is no difficulty, on any of the principal tributaries of the upper Ohio, in obtaining reservoirs capable of holding from twelve to twenty thousand millions of cubic feet. It can scarcely be doubted that twelve or fifteen sites for dams may be selected capacious enough to hold all the excess of water, and equalise the annual discharge so nearly that the depth may be kept within a very few feet of an invariable height."

To control the floods of the river, however, much less than this would be needed. Mr. Ellett takes the case of the flood of March 1841, as being that in which the greatest quantity of water passed down of all the floods concerning which he has information. He takes 25 feet of depth on the bar as the high-water mark, above which the river is in flood; he estimates that during nine days of flood the river passed down 159,000,000,000 cubic feet of water, while during the same time, had it been steady at the high-water mark, the discharge would have been only 115,000,000,000. If consequently the excess of 44,000,000,000 had been kept back in reservoirs, the flood would have been prevented.

The volume it is here proposed to deal with—44,000,000,000 cubic feet—is "just equal to the quantity the river would discharge in fifty days when there is a depth of five feet in the channel."

The valley of the upper Alleghany, one of the tributaries of the Ohio, is about a third of a mile in width. A dam from 55 to 60 feet in height, thrown across the trough of this valley, so as to submerge not only the main valley but its branches, would, according to Mr. Ellett, "probably form a lake covering from 16 to 18 square miles, with an average depth of nearly 30 feet, and containing more than 12,000,000,000 cubic feet of water." "It follows then that we should need but four dams, such as we have described, to secure the valley of the Upper Ohio against all destructive floods.

This however assumes that at the beginning of a flood the reservoirs will be empty—a condition on which it would not be safe to rely. It also seems that the shape of the valleys of the tributaries of the Ohio is everything that could be wished by an engineer who desired to convert them by means of dams into artificial lakes. They are trough-shaped, moderately wide, long, and not too steep. This last is a great advantage, because the steeper the valley the shorter is the lake that will be formed by a dam across it. It is likely that the Garonne and its tributaries are less favourably circumstanced, but nevertheless in a country of such varied contour as the south-west of France, there must be many eligible sites for reservoirs. In another way also the Garonne will certainly be found a less manageable river than the Ohio, namely that the volume of its floods bears a much higher ratio to its ordinary flow.

After the disastrous floods of the Loire in 1855, the late Emperor wrote a letter to his Minister of Public Works recommending the control of the floods by means of a number of small reservoirs to be formed by building dams across the mountain valleys. This however was lost sight of, and we see the result in the ruins of Toulouse.

A most useful work of this kind has been in operation for many years in Ireland. The following particulars are taken from a paper "on the Industrial Uses of the Upper Bann River," by John Smyth, jun., C.E., read at the Belfast Meeting of the British Association last year, and ordered by the General Committee to be printed *in extenso.*

The purpose of the reservoirs on the Bann is not to prevent floods, which, so far as we are aware, were never particularly disastrous on that river, but to equalise the flow of the river for water-power. "In 1835 the principal mill-owners formed themselves into a provisional committee to take steps to procure a better and more regular supply of water by the construction of reservoirs. They placed the matter in the hands of Sir William Fairbairn, who, assisted by J. F. Bateman, Esq., surveyed the collecting grounds of the river Bann and its several tributaries." Under their advice two reservoirs were constructed at Lough Island Reavy and Corbet Lough.

The Lough Island Reavy reservoir is 250 acres in extent, and contains 270,000,000 cubic feet. It cost 15,000*l.* to construct, besides 6,000*l.* for land. It is 430 feet above the sea-level, and is supplied by two mountain-streams. Its drainage area, including the lake itself, is only about five square miles, and it is filled and emptied only once in the year.

The Corbet reservoir is lower down than the other, and is chiefly filled from the Bann itself. Its extent is 70 acres, and its capacity 28,000,000 cubic feet. It "has been of much more service than its capacity would lead one to expect, as it may be filled and emptied four or five times in each year by small floods in the river, and all the Sunday water can be sent into it, and let down to the mills on Monday and Tuesday. It is generally exhausted before the upper reservoir is called on, and keeps up a supply when there is a scarcity in frosty weather."

The purpose of regulating the supply has been tolerably well attained. "A register of the daily height of the water in Lough Island Reavy has been kept since 1847. It shows that this reservoir has been of great service, as during 26 years an average supplementary supply of about two-fifths of the standard summer discharge allowed over Ervin's Weir, or about 30 cubic feet per second, has been granted, for, on an average, 102 days yearly: and the reservoir has been empty, on an average, eleven and a half days yearly." "The register of the Corbet reservoir has not been kept so long or so accurately as that of Lough Island Reavy; from the average of three years, however, and comparison with the register of Lough Island Reavy, I calculate it has given 120,000,000 cubic feet in the year, exactly one half that of Lough Island Reavy, or a good supply for fifty-one days; add to this the Lough Island Reavy supply, and there is a total of 153 days of twenty-four hours each." "As the supply from the reservoirs has only failed, on an average, eleven and a half days yearly, the standard water power may be said to have been almost constantly maintained:—indeed it is almost as good as steam-power, but at much less cost."

The income of the Company which has made the reservoirs is derived from a charge authorised by their Act of Parliament of 10*l.* per annum per foot of fall occupied by manufactories, and half of this when occupied by flax scutching mills and country corn-mills. The total fall from the upper reservoir to the bottom of the lowest fall is 350 feet, of which 180 are occupied by machinery. The capital of the Company is 31,000*l.*, and the dividend about three per cent., with a certainty of increase, if the advance in the price of coals, and the expected opening of the higher part of the district by railway, lead to more of the falls being occupied.

We think the calculations we have quoted from the American engineer, and the example of what has been done on a comparatively small scale in Ireland, are enough to show that the most difficult problems of the regulation of the flow of rivers may be approached with great hope of success.

## *THE GIGANTIC LAND TORTOISES OF THE MASCARENE AND GALAPAGOS ISLANDS**

### II.

ALTHOUGH the island of Aldabra is a British possession, its distance from the Mauritius and the Seychelles renders a supervision on the part of the Government very difficult, and no control whatever can be exercised on crews of ships who land there chiefly for the purpose of cutting wood, which they require for curing fish, &c. Information having reached England in the course of last year that it was intended to lodge permanently wood-cutting parties on the island, the speedy extinction of the tortoises seemed imminent; and the time to prevent this seemed all the more opportune, as the then Governor of the Mauritius, Sir Arthur Gordon, was known to take great interest in all matters relating to natural history. Consequently the following memorial was addressed to him, signed by the presidents of the Royal and Royal Geographical Societies, and other men of science who had made researches into the extinct fauna of these islands:—

*To His Excellency the Hon. Sir Arthur Hamilton Gordon, K.C.M.G., Governor and Commander-in-Chief of Mauritius and its dependencies.*

We, the undersigned, respectfully beg to call the attention of the Colonial Government of Mauritius to the imminent extermination of the Gigantic Land Tortoises of the Mascarenes, commonly called "Indian Tortoises."

2. These animals were formerly abundant in the Mauritius, Réunion, Rodriguez, and perhaps other islands of the western part of the Indian Ocean. Being highly esteemed as food, easy of capture and transport, they formed for many years a staple supply to ships touching at those islands for refreshment.

* The substance of this article is contained in a paper read by the author before the Royal Society in June, 1874, which will appear in the forthcoming volume of the "Philosophical Transactions," and to which I must refer for the scientific portion and other details. Some facts which have come to my knowledge subsequently to the reading of this paper, are added. Continued from p. 239.

3. No means being taken for their protection, they have become extinct in nearly all these islands, and Aldabra is now the only locality where the last remains of this animal form are known now to exist in a state of nature.

4. We have been informed that the Government of Mauritius have granted a concession of Aldabra to parties who intend to cut the timber on this island. If this project be carried out, or if otherwise the island is occupied, it is to be feared, nay certain, that all the tortoises remaining in this limited area will be destroyed by the workmen employed.

5. We would, therefore, earnestly submit it to the consideration of Your Excellency whether it would not be practicable that the Government of Mauritius should cause as many of these animals as possible to be collected before the wood-cutting parties or others land, with the view of their being transferred to the Mauritius or the Seychelle Islands, where they might be deposited in some enclosed ground or park belonging to the Government, and protected as property of the Colony.

6. In support of the statements above made and the plan now submitted to the Mauritius Government, the following passages may be quoted from Grant's "History of Mauritius" (1801, 4to.):—

"We (in Mauritius) possess a great abundance of both land and sea turtle, which are not only a great resource for the supply of our ordinary wants, but serve to barter with the crews of ships" (p. 194).

"The best production of Rodriguez is the land-turtle, which is in great abundance. Small vessels are constantly employed in transporting them by thousands to the Isle of Mauritius for the service of the hospital" (p. 100).

"The principal point of view (in Rodriguez) is, first, the French Governor's house, or rather that of the Superintendent, appointed by the Governor of the Isle of France, to direct the cultivation of the gardens there and to overlook the park of land-turtles. Secondly, the park of land-turtles, which is on the sea-shore facing the house." (p. 101.)

7. The rescue and protection of these animals is, however, recommended to the Colonial Government less on account of their utility (which nowadays might be questioned in consideration of their diminished number, reduced size, and slow growth, and of the greatly improved system of provisioning ships which renders the crews independent of such casual assistance), than on account of the great scientific interest attached to them. With the exception of a similar tortoise in the Galapagos Islands (now also fast disappearing), that of the Mascarenes is the only surviving link reminding us of those still more gigantic forms which once inhabited the Continent of India in a past geological age. It is one of the few remnants of a curious group of animals once existing on a large submerged continent, of which the Mascarenes formed the highest points.

It flourished with the Dodo and Solitaire, and whilst it is a matter of lasting regret that not even a few individuals of these curious birds should have had a chance of surviving the lawless and disturbed condition of past centuries, it is confidently hoped that the present Government and people who support the "Natural History Society of Mauritius" will find the means of saving the last examples of a contemporary of the Dodo and Solitaire.

London, April 1874

[*Here follow the signatures.*]

This memorial was most favourably received by Sir A. Gordon, who in his reply states that, although the intention of conceding the island to parties for the purpose of cutting wood had not yet actually been carried out, the extermination of the tortoises is proceeding quite as rapidly as if this were the case. Not only are the animals destroyed by the whalers, but (as he was informed by visitors to the island) the pigs, which are supposed to have been left there by a passing ship some years ago, and which have rapidly multiplied, turn up the eggs in great numbers, and even devour the very young tortoises. The lessee should be bound to protect the animals and to remit annually to Mauritius a pair of living ones which, with others acquired by purchase, would be preserved in a paddock of the Botanic Gardens at Pamplemousses. He adds that in several of the Seychelle Islands such paddocks exist, the young tortoises being esteemed as articles of food; at four years they appear to be considered fit for eating; but he never observed that any are allowed to grow up as breeding stock to replace the original pair.

We confidently hope that Sir A. Gordon's successor will not lose sight of this matter and that the Royal Society of Arts and Sciences of Mauritius, to whom a copy of the memorial has been sent, with the request to support the appeal of their fellow-labourers in England, will recognise it as one of their duties to watch that the existence of one of the most interesting animal types within the limits of their own special domain, is not only prolonged but insured for all times.

We owe it chiefly to the kind mediation of Sir A. Gordon that a living pair of the Aldabra Tortoises are at present in London. Anxious to acquire this pair for the collection of the British Museum, the male being known to be the finest individual of the species in existence, I requested Sir A. Gordon to assist me in their acquisition, the owner being at first reluctant to part with them. To the excellent arrangements of the Hon. C. S. Salmon, Chief Commissioner of the Seychelles, and to the most fortunate circumstance that Dr. Brooks, the Government Medical Officer, accompanied and took charge of the animals on their journey to Europe, we have to thank that they arrived in the most perfect state of health. The Zoological Garden being clearly the most appropriate place for them during their lifetime, I handed them over to the Zoological Society, and have no doubt that, with the interest taken in this subject by Mr. Sclater, and with the care bestowed on them by Mr. Bartlett, these animals have a better chance of surviving their transmission into our severe climate than the specimens imported some thirty or forty years ago.* Mr. Salmon writes that both the tortoises are natives of Aldabra, though not of the same breed. The larger, the male, has been in the Seychelles for about seventy years; its last proprietor, M. Deny Calais, kept it with the female in a semi-domesticated state on Cerf Island. His weight is about 800 lbs.; the length of the shell 5 ft. 5 in. (in a straight line), the width 5 ft. 9 in.; † circumference of the shell, 8 ft 1 in.; circumference of fore leg, 1 ft. 11 in., and of hind leg, 1 ft. 6 in.; length of head and neck, 1 ft. 9 in.; width of head, 6 in. The female is much smaller, and I have no information as regards the time she was brought to the Seychelles. The length of her shell is 3 ft. 4 in., the width 3 ft. 10 in., the circumference 5 ft. 4 in. She lays thrice every year, in the months of July, August, and September, each time from fifteen to twenty round hard-shelled eggs. There is every reason to believe that the laying of eggs will not be interrupted by the transmission of the animals to England.

Every one who sees these two tortoises side by side is at once struck by the great difference in form and sculpture of the shell. That of the male is remarkably high, with a rounded outline, each plate being raised into a hummock, and deeply sculptured with concentric furrows along the margins. The female, on the other hand, has a perfectly smooth shell with an oval outline, without either furrows or raised portions. The shell of the male is brownish, that of the female black. The male has also a comparatively longer neck and tail than the female. It is quite possible that these are sexual differences, the males being known to grow to a much larger size than the females. But as Aldabra consists of three islands, separated by channels of the sea which are impassable barriers to animals which may float but cannot swim, it may be presumed that the two animals come from distinct islands, each island of the group being inhabited by a distinct race, as in the Galapagos. This is a question

* I have kept young specimens of the Aldabra Tortoise (two of which are the offspring of the very individuals now imported), as well as half-grown ones of the Galapagos species, for years. Want of water and a twenty-four hours' exposure to a temperature below 50° are fatal to them. In the autumn and winter they must be kept in a greenhouse where the temperature should be kept at about 70°. With a plentiful and varied supply of vegetables, they thrive well and grow perceptibly.

† A large example, probably of the Rodriguez species, which formerly lived in the Zoological Gardens, and is described in Proc. Zool. Soc., 1833, p. 81, weighed 280 lbs., the shell being 4 ft. 4½ in. in length (over the curve), and 4 ft. 9 in. in width.

the investigation of which I would particularly recommend to persons visiting Aldabra.

Mr. Salmon states that the male shows himself to be annoyed when the female is disturbed, and there is no doubt that he exhibits affection for her, as was especially evident on board the steamer, when he tried to break out of his cage as soon as he got sight of the female, who was transported in a separate cage. The circumstance that the two animals are a pair, increases the chances in favour of their being kept alive for a lengthened period. And they will be well worth all the care we can bestow on them, as it is extremely doubtful whether we shall ever succeed again in obtaining a pair of full-grown examples. The male is without doubt the largest and most powerful individual of its race, far exceeding in size any of the few other individuals kept in the Seychelles. Nor is it likely that in Aldabra itself a similarly large example should have succeeded in evading the search of the numerous crews which have landed there.

From the historical evidence given above, it is evident:

1. That the presence of the Gigantic Tortoises at two so distant stations as the Galapagos and Mascarenes cannot be accounted for by the agency of man, and therefore that these animals must be regarded as indigenous.

2. That, although frequently transported by the early navigators to distant and apparently suitable localities (Sandwich Islands, Masa Fuero, and Ceylon), they never established themselves permanently, but there is no evidence to show whether this failure is due to an innate inability of the species to become acclimatised when far removed from its native place, or to the destructiveness of the inhabitants of those localities.

3. That the different islands of the Galapagos group were inhabited by distinct races.

4. That possibly the animals even of so small a group as Aldabra were differentiated in the different islands.

5. That although these animals are still lingering in the Galapagos and Aldabra their numbers are yearly diminishing, and that their growth to perfect maturity is interrupted; that with respect to the races of the Galapagos Tortoise, the elucidation of the irdistinctive characters and original distribution, we are, and probably shall be, dependent chiefly on the materials already preserved in zoological museums.

6. That the Tortoises of Mauritius and Rodriguez are entirely extinct. It is probable that in some museums shells, or even entire animals of these once so numerous races exist, but it will be a matter of great difficulty to trace their origin; therefore our examination is limited at present to the osseous remains transmitted from the Mauritius and Rodriguez.

ALBERT GÜNTHER

(*To be continued*)

## NOTES

WE are glad to hear that both a zoological and botanical collector will form part of the retinue of the Prince of Wales, in his approaching visit to India.

DR. VOGEL (not the photographer of that name), the Director of the newly established "Sonnenwarte" of Berlin, is now in this country.

THE rate of propagation of the recent inundation waves in the south of France has been determined along the banks of the Garonne. It was found to have been no more than two miles an hour in a run of 140 miles in the district where the principal calamities occurred. The consequence is that an immense amount of property and life could have been saved if a system of warnings had been adopted. Wise as usual after the event, the authorities intend to establish such a system as is already in operation at Lyons for the Rhône, and at Paris for the Seine. In an article in the July number of *Symons's Monthly Meteorological Magazine*, on the French floods, is an interesting calculation which ill give Londoners some idea of what a "flood" means. Supposing we had a flood in the Thames, it would cover on the south bank, the whole of Battersea Park, Lambeth, Southwark, Bermondsey, and Deptford; and on the north bank, Fulham, Chelsea, Brompton, Belgravia, Westminster, and St. James's Park; while, as for the new embankment, a steamer might ply over the top of it.

IT is suggested that the unusual violence of the floods on the continent are attributable not only to the abnormal amount of rain and the sudden melting of snow and ice in the mountain districts, but also to the increasing destruction of forests which is taking place in nearly every country. For some years past the violence of the spring and summer floods has been increasing, and it is remarkable that this increase in their force is contemporaneous with the gradual extinction of forests and woodlands. The existence of forests has a great effect in equalising the distribution of water, and in checking the too rapid melting of snow and ice under the influence of the summer heat. At the same time the growth of timber on hill sides prevents the rapid flow of surface-water which takes place where trees do not exist. The question of maintaining forests, instead of destroying them, without making provision for the future, is one which demands the serious attention of the governments of every country, and particularly of those countries where, by the existence of hills and mountains, and consequently rapid rivers, the liability to floods is increased.

WE have been informed that during the recent very bad weather there has been an unusual number of icebergs met with in the North Atlantic, and that fogs in Labrador and Newfoundland have been extraordinarily severe and frequent. It is to be hoped that some general inquiry into the recent peculiar weather and its accompaniments will be instituted; no doubt valuable results would be obtained.

THE Austrian Commission to the International Geographical Exhibition has intimated that they intend to present to the French Geographical Society all the books they are exhibiting. As this example will, we are informed, be followed by other Commissions, a magnificent Geographical Library will be one of the results of the meeting of the Congress.

THE work of the Sub-Wealden Exploration is temporarily arrested at 1,672 feet from increasing deposit from the sandy beds. The original problem was dependent on the opinion of geologists that palæozoic rocks would be found at a depth varying from 700 to 1,700 feet. So far, however, the strata are mesozoic; but the latest fossils give some indications of a palæozoic rock. Much hope is therefore entertained of solving the problem.

PARTS 19 to 24 of the quarto work published by authority of the Lords Commissioners of the Admiralty, on the Zoology of the Voyage of H.M.S. *Erebus* and *Terror*, conclude the descriptions of the Mammalia by the late Dr. J. E. Gray, F.R.S.; the Birds by Mr. R. B. Sharpe; the Reptiles by Dr. A. Günther, F.R.S.; and the Insecta by Mr. A. G. Butler. Part 20 is by Mr. E. J. Miers on the Crustacea, and Part 21 by Mr. E. A. Smith on the Mollusca.

THE Rev. E. Ledger, M.A., rector of Duxford, Cambridgeshire, was yesterday elected to the Gresham Professorship of Astronomy in the City of London. Mr. Ledger was a Carpenter and Beaufoy Scholar of the City of London School, and afterwards Fellow and Lecturer of Corpus Christi College, Cambridge. He was fourth Wrangler in 1863, and also University Scholar of the University of London.

AN International Horticultural Exhibition and Congress is to be held in Amsterdam in 1876, similar to the one held in Florence last year. A strong committee has been appointed, who desire the co-operation of the various horticultural societies throughout Europe in making the undertaking as complete and successful as possible. The President is to be Mr. J. H. Krelage, and the Secretary Mr. H. Groenewegen.

MR. THISELTON DYER, in consequence of his recent appointment to Kew, has resigned the Professorship of Botany at the Royal Horticultural Society.

DR. HOFFMANN, of Giessen, contributes an interesting article on the influence of inland-water on the vegetation of shore-lands to the *Oesterreichisches Landwirthschaftliches Wochenblatt* of July 10. His object is to prove that large bodies of water tend to produce an equable climate, and that a large percentage of heat and light is due to the reflected rays of the sun from the surface of the water. To illustrate his argument he selects that part of the river Rhine which flows from east to west, from Biebrich to Niederwald, where the northern bank more particularly in the immediate vicinity of the water produces the best grapes in Germany. Moreover, he states that the fogs rising from the water in the month of May protect the tender shoots of the vine from being injured by late frosts. This, at any rate, does not agree with our experience in this country.

IT is stated that, in consequence of pressure of business, the Government is not likely to be in a position, during the present session, to return any final answers to the applications for aid made on behalf of King's College, London; Owens College, Manchester; the University College of Wales; and other educational bodies throughout the country.

LORD ABERDARE has been elected President of the Social Science Association for the ensuing year.

IN a pit about half a mile east of Erith Railway Station, where an old and deserted bed of the Thames is excavated for brick earth, and which has yielded the bones of two species of British elephant and one of lion, Dr. Gladstone, F.R.S., was so fortunate as to find, on Saturday last, a large flint implement of palæolithic make. The implement is seven inches in length, slightly convex, and chipped on the outer curve with three longitudinal faces; consequently it has four working edges. At the butt end an echinus, or sea urchin, is embedded in the flint.

IN some excavations which have recently been undertaken during the construction of the continuation of the Thames embankment westwards, some probably prehistoric remains have been brought to light, which include a human lower jawbone with all the teeth present. At about the same spot a flint knife was discovered and other animal remains, some mixed with freshwater shells.

IN the Proceedings of the Bristol Naturalists' Society (Vol. I. Part ii.) will be found the translation, by Dr. Fripp, of a valuable paper by Dr. E. Abbe, of Jena, entitled, "A Contribution to the Theory of the Microscope, and the Nature of Microscopic Vision."

THE University of California has organised a summer exploring party, which will be occupied about nine weeks in journeying through the Sierra Nevada Mountains in Mariposa, Mono, and Inyo counties, and will bestow particular attention to geology, palæontology, and mineralogy. The party will be in charge of Dr. Joseph Le Conte, assisted by Mr. Henry Edwards, Mr. F. P. M'Lean, and Mr. F. Slate.

SIR CHARLES LOCOCK, Bart., F.R.S., First Physician-Accoucheur to the Queen, died on Friday last, at the age of seventy-six years.

THE British Archæological Association meets this year at Evesham, on Monday, August 16, when the President, the Marquis of Hertford, will deliver the inaugural address.

A REUTER'S telegram states that an attack has been made on the Palestine exploring party, none of whom have, however, been hurt. The assailants were repulsed.

THE rector of the Catholic University of Louvain (Belgium) has gone to Paris in order to consult with the ecclesiastics now engaged in preparing to establish a Catholic University in that city. The site has been already chosen, and is close to the place where *La Bastille* was erected during the old Monarchy. The liberals are not likely to establish a University of their own, if the existing University satisfies their principal claims.

A CAPITAL weekly journal, the *Electrical News and Telegraphic Reporter*, whose first appearance we intimated a few weeks ago, has just completed the first month of its existence. It is edited with care and ability by Mr. Crookes, and is uniform in size and price with the *Chemical News*. In the number for July 22 there are nine articles of considerable scientific value and others of no less general interest. We notice especially the paper on Quadruplex Telegraphy and the Telegraph in China. The notes are interesting, and the reports of electrical science from the foreign journals are well done. We are glad to be able to bring this useful journal under the notice of our readers.

AN examination will be held at Exeter College, Oxford, on Thursday Oct. 14, for the purpose of election to two scholarships in Natural Science, of the annual value of 80*l*. each, tenable for five years.

WE have received the "Second Appendix" to the "Flora of Liverpool," issued by the members of the Field Club. It contains additional habitats for many species, and also includes several species not previously recorded as growing in the district, some of them of considerable rarity, as: *Ranunculus fluitans*, *Barbarea stricta*, *Carduus nutans*, *Doronicum Pardalianches*, *Cusenta Europæa*, *Mentha rubra*, *Stachys ambigua*, *Atriplex triangularis*, *Rinnex pratensis*, *Alisme natans*, *Carex divulsa*, *axillaris* and *fulva*. Local "floras" are becoming so numerous now, and the directions for finding certain plants so minute, that there is some point in the remark of a facetious foreign professor of botany, who said that we should soon have have all our British plants separately labelled. This defect (in our opinion) is rather conspicuous in the Appendix to the Flora of Liverpool. It may be desirable to know something about the number of individuals of exceedingly rare though undoubtedly indigenous species.

MR. DALL has presented a report to the United States Coast Survey on the tides, currents, and meteorology of the Northern Pacific. He finds proof of the existence of a northerly current, denominated by him "the Alaska current," which had previously been surmised.

VOL. VI. of Mr. F. V. Hayden's Report of the U.S. Geological Survey consists of a monograph, by Mr. Leo Lesquereux on the Cretaceous Flora of the Western Territories, profusely illustrated. Mr. H. Gannett, under the same direction, has issued the third edition of a List of Elevations west of the Missouri River.

THE additions to the Zoological Society's Gardens during the past week include, a Chimpanzee (*Troglodytes niger*) from W. Africa, presented by Capt. Lees, Govenor of Lagos, W. Africa; three Amherst Pheasants (*Thaumalea amherstiæ*); a Geoffroy's Blood Pheasant (*Ithaginis Geoffroyii*) and five Temminck's Tragopans (*Ceriornis Temminckii*) from China, deposited; a Sambur Deer (*Cervus aristotelis*), two Brown Indian Antelopes (*Tetraceros subquadricornutus*) from India, a Tora Antelope (*Alcelaphus tora*) from Upper Nubia, an Elate Hornbill (*Buceros elatus*), an Electric Silurus (*Melapterurus beninensis*) from W. Africa, a Naked-throated Bell Bird (*Chasmorhynchus nudicollis*), a Pectoral Tanager (*Ramphocœlus brasilius*), a Festive Tanager (*Calliste festiva*) from Brazil, purchased.

## SOCIETIES AND ACADEMIES

### London

**Geological Society,** June 23.*—Mr. John Evans, V.P.R.S., president, in the chair.—On the Granitoid and associated Metamorphic Rocks of the Lake-district, by J. Clifton Ward.

Part I. *On the Liquid Cavities in the Quartz-bearing Rocks of the Lake-district.*—The object of this paper was to examine into the evidence afforded by the liquid cavities of the granitoid rocks of the Lake-district, with reference to the pressure under which these rocks may have consolidated. In the first division of the subject the geological relations of the three granitic centres of the district were considered, and it was shown that these several granitic masses probably solidified at depths varying from 14,000 feet to 30,000 feet. The most probable *maximum* depth for the Skiddaw granite was stated as 30,000 feet; the *maximum* for the Eskdale granite 22,000 feet; and for the Shap granite 14,000 feet. These maximum depths were arrived at by estimating the greatest thickness of strata that were ever, at one time, accumulated above the horizon of the top of the Skiddaw slates. The mode of microscopic examination, together with a description of the precautions taken in measuring the relative sizes of the cavities and their contained vacuities, formed the second division of the paper. It was stated that all the measurements used in the calculations were made from cases in which the vacuity mixed freely in the liquid of the cavity, and an approximately *perfect* case for measurement was defined to be one in which the outline of the liquid cavity was sharply defined all round in one focus, and in which the vacuity moved freely to every part of the cavity *without going out of focus*. Then followed the general results of the examination. Restricting the measurements to such cases as those above mentioned, the results were found to be generally consistent with one another, and with those previously obtained by Mr. Sorby in his examination of other granitic districts. From the fact that the calculated pressure in feet of rock was in all cases greatly in excess of the pressure which could have resulted from the thickness of overlying rocks, it was inferred as probable that these granitic masses were not *directly* connected with volcanic action, by which the pressure might have been relieved, but that the surplus pressure was spent in the work of elevation and contortion of the overlying rocks. Microscopic, combined with field evidence, was thought to indicate that the Shap granite, though mainly formed at a depth similar to that at which the Eskdale granite consolidated, was yet itself finally *consolidated* at a much less depth, the mass having eaten its way upwards at a certain point, and perhaps representing an unsuccessful effort towards the formation of a volcanic centre. The examination showed that the *mean* of the pressures under which the Lake-district granites probably consolidated was nearly the same as the *mean* which Mr. Sorby arrived at for those of Cornwall. In conclusion the author stated that he wished these results to be considered as preliminary only, since the *complete* investigation would necessarily occupy far more time than was at his disposal; at the same time he ventured to hope that *general* accuracy was insured, while pointing to the many little-known causes which might affect the conclusions.

Part II. *On the Eskdale and Shap Granites, with their associated Metamorphic Rocks.*—The author brought forward evidence in this paper to prove the possibility of the formation of granite by the extreme metamorphism of volcanic rocks. The passage is shown in the field, and may be observed in a complete series of hand specimens. Frequently, indeed, the actual junction is well marked, but in other cases the transition is gradual; and there occur at some little distance from the main mass, inlying patches of what may be called bastard granite. The microscopic examination proves the passage from a distinctly fragmentary (ash) to a distinctly crystalline rock, and to granite itself. Also the chemical composition of the altered rocks agrees very closely with that of the granite. Both Eskdale and Shap granite were believed to have been formed *mainly* from the rocks of the volcanic series by metamorphism at considerable depths; but the granite of Shap was thought to be in great measure intrusive amongst those particular beds which are now seen around it. A decided increase in the proportion of phosphoric acid was noted in the volcanic rocks on approaching the granite, and a decrease in carbonic acid.

On the Correlation of the Deposits in Cefn and Pontnewydd Caves, with the Drifts of the neighbourhood, by Mr. D. Mackintosh. Believing that the time has arrived for making some attempt to correlate cavern-deposits with glacial and interglacial drifts, the author ventures to bring forward the results of a personal examination of the remnants of the deposits in Cefn and Pontnewydd caves, compared with old accounts given by Mr. Joshua Trimmer and others. He has been led to regard the following as the sequence of deposits before the caves were nearly cleared out (order ascending):—1. Loam with bones and smoothly rounded pebbles, nearly all local (cemented into conglomerate in Pontnewydd cave). As a few foreign pebbles of felstone have been found in this bed, it could not have been deposited by the adjacent river Elwy before the great glacial submergence; and the author gives reasons for believing that it was not introduced by a freshwater stream from the boulder-clay above in Post-glacial times, but that it may possibly represent the middle drift of the plains, and may have been washed in by the sea during the rise of the land. After emergence, and during a comparatively mild interglacial period, bones of animals may have been introduced by rain through fissures in the roof of the cave, and these may have become partly mixed up with the underlying pebbly deposit. 2. Stalagmite, from less than an inch to two feet in thickness, accumulated during a continuance of favourable conditions (apparently absent in Pontnewydd cave). Bones of animals were again brought in by rain or by hyænas, and were afterwards worked up into the following deposit:—3. Clay, with bones, angular and subangular fragments of limestone, pebbles of Denbighshire sandstone, felstone, &c. (palæolithic flint implements and a human tooth in Pontnewydd cave according to Prof. T. M'Kenny Hughes). This clay once filled the Cefn cave nearly to the roof. There are reasons for believing that it was principally introduced through the mouth of the cave, that it is of the same age with the neighbouring upper boulder-clay, and that it is not a freshwater redeposit of that clay. It was probably washed in during a second limited submergence. 4. Loam and coarse sand charged with minute fragments of sea-shells. Portions of this deposit may still be found in the Cefn cave; and it may have been introduced through fissures in the roof by the sea as the land was finally emerging.

Geological Notes from the State of New York, by Mr. T. G. B. Lloyd, C.E. The substance of this paper comprises notes, accompanied by drawings and sketches of various matters of geological interest which fell under the author's observation whilst residing some years ago in the State of New York. The different subjects are divided under the following heads:—(1) Groovings and channelings in limestone running across the bed of Black River at Watertown, Jefferson co. (2) Descriptions of the superficial beds of boulder-clay, sand, and gravel which were exposed to view in the district around the village of Theresa during the construction of the Black River and Morristown railroad. (3) A description, with a general and detailed drawing to scale, of a remarkable "Giant's Kettle" near Oxbow, in Jefferson co. (4) An account of some peculiar flower-pot-shaped blocks of sandstone discovered in a quarry of Potsdam sandstone at the village of Theresa. The author in conclusion refers to a statement in a paper on Niagara by Mr. Belt, F.G.S., published in the *Quart. Journ. of Science* for April 1875, in which it is stated that the sections described as occurring near the Falls are typical of the superficial beds that mantle the whole of the northern part of the State of New York and Ohio and much of Canada. He is unable to find any description of a deposit which bears a near resemblance to the boulder-clay occurring in the district around the village of Theresa, in the descriptions of various authors of the superficial deposits of the northern part of the State of New York and Canada. He therefore ventures to remark that no section can be considered as typical of the whole of the north part of the State of New York which does not recognise the existence of the deposit in question.

On a Vertebrate Fossil from the Gault of Folkestone, which also occurs in the Cambridge Greensand, by Prof. H. G. Seeley, F.L.S. The author describes a bone having the general form of an incisor tooth obtained from the Gault of Folkestone by Mr. J. S. Gardner, F.G.S. The flattened cylindrical end of a specimen from the Cambridge Greensand has been figured as a caudal vertebra of *Pterodactylus simus*. A microscopic section of the expanded end of a specimen from the Cambridge Greensand exhibits ordinary osseous tissue, showing that the fossil is probably a dermal spine from the tail of a Dinosaur. The Gault specimen is smaller than the examples from Cambridge.

**Royal Horticultural Society,** July 7.—Scientific Committee.—J. D. Hooker, F.R.S., in the chair.—A paper on the resting-spores of the potato disease was read by Worthington

* Continued from p. 243.

Smith, F.L.S. These were identified with the bodies which Mr. Berkeley had lately regarded as a species of *Protomyces*, and the cause of a new malady in the potato. The following are the principal points in this very important communication:—On receiving authentic specimens of diseased plants from Mr. Barron, Gardener-in-Chief to the Society, the brown spots on the potato-leaves at once called to mind the figures of some species of *Protomyces*, and the dimensions agreed tolerably well with some described plants of that genus, but the spots, when seen under a high power, appeared very unlike any fungus, and they were very sparingly mixed with other bodies much smaller in diameter, and with a greater external resemblance to true fungus spores. These latter spore-like bodies were of two sizes—one transparent and of exactly the same size as the cells of the leaf (and therefore very easily overlooked), and the other dark, reticulated, and much smaller. A few mycelial threads might be seen winding amongst the cellular tissue. The author's opinion, therefore, was soon formed that the "new" potato disease was no other than the old *Peronospora infestans* in an unusual and excited condition. That climatic conditions had thrown the growth of this fungus forward and out of season was probable; but the idea that the pest would not at length attack all and every sort of potato seemed unreasonable, though the more tender sorts might be the first to suffer. From day to day the diseased leaves and stems and tubers were kept between pieces of very wet calico, in plates under glass, and it was immediately noticed that the continued moisture greatly excited the growth of the mycelial threads. So rapid was now the growth of this mycelium, that after a week had elapsed some decayed parts of the lamina of the leaf were traversed in every direction by the spawn. In about ten days the mycelium produced a tolerably abundant crop, especially in the abortive tubers, of the two-sized bodies previously seen in the fresh leaves. The larger of these bodies Mr. Smith was disposed to consider the "oospore" of the potato fungus, and the smaller bodies as the "antheridia" of the same fungus, which are often terminal in position. The filaments of the latter are commonly much articulated, and sometimes more or less moniliform or necklace-like. Both oospore and antheridium are very similar in nature and size to those described as belonging to *Peronospora alsinearum* and *P. umbelliferarum*, and this is another reason (beyond the occurrence of undoubted *P. infestans* on potato-leaves at the beginning of June) why he was disposed to look upon these bodies as the oospore and antheridium of the potato fungus. The larger bodies are at first transparent, thin, pale brown, furnished with a thick dark outer wall, and filled with granules; at length a number (usually three) of vacuities or nuclei appear. The smaller bodies are darker in colour, and the external coat is marked with a few reticulations, possibly owing to the collapsing of the outer wall. At present he had been unable to detect any fecundating tube (described as belonging to the antheridium of other species of *Peronospora*), but he had observed the two bodies in contact in several instances. After fertilisation has taken place, the outer coat of the oospore enlarges, and appears to be cast off. Both antheridium and resting-spore are so slightly articulated to the threads on which they are borne that they are detached by the slightest touch, but with a little care it is not really difficult to see both bodies *in situ*; and my observations lead me to think that conjugation frequently takes place after both organs are quite free. The antheridia and oospores are best seen in the wettest and most thoroughly decomposing tuber, but they occur also in both the stem and leaf. The author was also disposed to regard Montagne's *Artotrogus* as identical with the resting-spore of *Peronospora infestans*, an opinion which had long been held by Mr. Berkeley.

### PARIS

**Academy of Sciences**, July 19.—M. Frémy in the chair.—The following papers were read:—On M. Espy's meteorological theory, by M. Faye.—On the continuation which it will be necessary to make of experimental researches on plasticodynamics, by M. de Saint-Venant. This new branch of mechanics treats of the internal motions of solid bodies in a state of plasticity. M. Tresca added some remarks on the same subject.—Experimental and clinical considerations on the nervous system with regard to its function in actions governed by the sensitive, instinctive and intellectual faculties, as well as in the so-called voluntary locomotive actions, by M. Bouillaud. The author arrives at the following conclusions: The cerebrum and the cerebellum are both absolutely necessary for all actions which are governed by the various faculties of mind or intelligence. The cerebellum is the seat of co-ordination of the movements of walking, the cerebrum being the seat of the co-ordinating centres of the movements necessary for the execution of a great number of intellectual actions, speech in particular.—On a distinction between natural and artificial organic products. The author repeats the distinction made by him in 1860, in reply to a statement by M. Schutzenberger. This distinction is that natural bodies are always unsymmetrical.—Observations relating to M. Hirn's communication of June 23. Importance of basing the new theory of heat on the hypothesis of the vibratory state of bodies, by M. A. Ledieu.—Note on the chronology and geography of the plague in the Caucasus, in Armenia, and in Anatolie during the first half of the nineteenth century, by M. J. D. Tholozan.—On the development of the spiny rays in the scale of *Gobius Niger*, by M. L. Vaillant.—On d'Arrest's periodic comet, by M. Leveau.—Observations of Jupiter's satellites during the oppositions of 1874 and 1875. Determination of their differences of aspect and of their variation of brilliancy, by M. Flammarion. In size the decreasing order is III., IV., I., II. Intrinsic luminosity for equal surfaces I., II., III., IV. Variability in decreasing order IV., I., II., III.—Note on magnetism; reply to an observation of M. Jamin, by M. J. M. Gaugain.—Oxy-uvitic and the cresol derived from it, by MM. A. Oppenheim and S. Pfaff. The cresol is metacresol.—On a compound of methyl oxide and hydrochloric acid, by M. C. Friedel.—On the diethylic ether of xanthoacetic acid, by MM. C. O. Cech and A. Steiner.—On the estimation of carbon disulphide in the sulphocarbonates of potassium and sodium, by MM. David and Rommier.—On the mode of action of the pillars of the diaphragm, by M. G. Carlet.—On the reproduction of eels, by M. C. Dareste.—The morphological elements of the oblong leaves of the monocotyledons, by M. D. Clos.—On a claim of priority relative to a fact of botanical geography, by M. Ch. Contejean.—During the meeting M. Mouchez was elected a member of the Astronomical section to replace the late M. Mathieu.

## BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Chambers' Encyclopædia. 10 vols., new and revised edition (W. and R. Chambers).—Reports of the Medical Officer of the Privy Council and Local Government Board. New Series, No. 3 (Spottiswoode).—On the Inequalities of the Earth's Surface viewed in connection with the Secular Cooling: Osmond Fisher, M.A. (Cambridge Philosophical Transactions).—Flora of Eastbourne: F. C. S. Roper, F.L.S. (Van Voorst).—Travels in Portugal: John Latouche (Ward, Lock, and Tyler).—Second Supplement to Watts's Dictionary of Chemistry (Longmans).—Transactions of the Manchester Geological Society, Vol. xiii. Part 10.—Health in the House: Catherine M. Buckton (Longmans).—Hydrology of South Africa: J. Croumbie Brown, LL.D. (H. S. King and Co.)—Rudiments of Geology: Samuel Sharp, F.S.A., F.G.S. (E. Stanford).—The Skull and Brain; their Indications of Character and Anatomical Relations: Nicholas Morgan (Longmans). North Staffordshire Naturalists' Field Club Addresses, Papers, &c.—On the Sensations of Tone as a Physiological Basis for the Theory of Music, by H. Helmholtz; translated by A. J. Ellis, F.R.S. (Longmans).—Reports and Proceedings of the Miners' Association of Cornwall and Devon for 1874.

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ERRATA.—Page 232, col. 1, line 24 from bottom, for "currents" read "cumuli"; line 22 from bottom, for "lovely" read "lowly."